ECOLOGICAL CONDITIONS IN COYOTE CANYON, ANZA-BORREGO DESERT STATE PARK®: An Assessment of the Coyote Canyon Public Use Plan

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EXECUTIVE SUMMARY

This report provides an assessment of changes in recreational quality, resource health, and resource protection in Coyote Canyon within Anza-Borrego Desert State Park® following implementation of the Coyote Canyon Public Use Plan in 1996. The objectives of the Public Use Plan were to improve resource protection and recreational quality in Coyote Canyon. The Department of Parks and Recreation committed to monitoring six components of the Coyote Canyon ecosystem (recreational quality, Coyote Creek, vegetation, amphibians, least Bell's vireo, and desert bighorn sheep) for a 5-year period to assess the effectiveness of the Public Use Plan in achieving its objectives.

Although data were unavailable to compare the quality of recreation both before and after plan implementation, two visitor use surveys indicated that recreational quality in the canyon was high following implementation of the Coyote Canyon Public Use Plan. Visitors valued the canyon's scenic beauty, unique characteristics, wilderness, and nature displays. In early 1998, 94% of visitors to Coyote Canyon rated their experience as good or excellent.

Because both surveys were conducted after the Public Use Plan was implemented, the results do not reflect the full range of past or potential users. However, the visitors surveyed ranked protection of natural resources a top management priority and they strongly supported current park management. Increasing the amount of off-road access in the canyon was the least supported management action, both within Coyote Canyon and park-wide. This illustrates that visitors surveyed in other areas of the park gave the same general response as visitors in Coyote Canyon. Most Coyote Canyon users (57%) were positively affected by changes associated with the Public Use Plan or had no comment (26%). Thirteen percent of users were negatively affected by management changes and 4% made negative comments unrelated to the Public Use Plan (i.e. regarding park-wide fees).

Prior to the road closure at Middle and Upper Willows, motor vehicle use through the streambed impacted riparian vegetation and incised (down cut) the streambed. Although major floods remove many signs of motor vehicle use, the diversifying function and long-term effects of floods are compromised by streambed incision. Closure of the road through Middle and Upper Willows increased the level of resource protection in Coyote Canyon and improved the status and integrity of the streambed, a factor of critical importance to the ecological health of the canyon.

The status of plant and animal resources during 1996-2001 either improved or remained stable. Systematic monitoring of seven transects in Middle and Upper Willows between 1997 and 2001 showed that shrub cover and height in Coyote Canyon significantly increased, and the amount of bare ground significantly decreased. Analysis of aerial photographs revealed a 28% increase in riparian vegetation at Middle Willows between 1995 and 2000. Removal of vehicular traffic from the streambed facilitated revegetation and vegetation succession.

Vegetation monitoring and annual bird surveys indicated that the status of least Bell's vireo and their habitat in Coyote Canyon both improved. The overall number of nesting vireo increased because of increases at Lower Willows. The recovery and improved protection of riparian vegetation at Middle and Upper Willows will enhance habitat conditions for least Bell's vireo and may enhance habitat for southwestern willow flycatchers.

Visual and aural surveys for amphibians indicated that no large or widespread changes in amphibian diversity or abundance occurred in recent years. Three species (red-spotted toads, California treefrogs, Pacific treefrogs) were found in surveys conducted at Upper, Middle, and Lower Willows both before and after Plan implementation. Based on information reported in the scientific literature, implementation of the Plan provided improved resource protection for amphibians.

Bighorn sheep in Coyote Canyon were monitored via waterhole counts, helicopter surveys, and monitoring of radio-collared animals. Results showed that bighorn sheep survival and reproductive success improved and the population size remained stable. If sustained, the increases in survival and reproduction should result in population increases in the future. The Public Use Plan improved protection for both bighorn sheep and their habitat.

Implementation of the Coyote Canyon Public Use Plan improved resource protection for all species monitored, and for the natural processes that largely account for the canyon's biodiversity. Maintaining the integrity of fundamental natural processes such as vegetation succession and disturbance regimes (floods) is essential to the long-term health of the Coyote Canyon ecosystem.

In conclusion, there was convincing evidence that the Plan provided a high quality of recreation, improved or stablilized natural resource health, and improved resource protection. Scientific literature and monitoring data support the conclusion that management actions specified by the Coyote Canyon Public Use Plan, particularly the road closure and cowbird and tamarisk control, were beneficial.

INTRODUCTION

Anza-Borrego Desert State Park® (ABDSP) in southern California encompasses 640,000 acres, which comprises roughly half the acreage of the entire State Park System and 87% of the State Wilderness System. ABDSP is designated as an International Biosphere Reserve and a National Natural Landmark. Coyote Canyon, located in the northwestern portion of the park, comprises approximately one-sixth of the park or about 100,000 acres (Figure 1). The natural and cultural resources of Coyote Canyon are among the richest of any area in Southern California and are considered to be the most extensive in ABDSP. Over 85 archeological sites have been recorded along the main creek in the Coyote Canyon, including major villages, food processing centers, rock art, and ceremonial and cremation sites. The canyon also contains habitat for three federally and state listed threatened or endangered species, and 52 sensitive species.

Coyote Creek, the longest perennial stream in San Diego County, is the largest watershed within ABDSP, encompassing approximately 154 square miles. It serves as the principal source of groundwater recharge for the Borrego Valley aquifer. The creek contains three reaches where bedrock forces groundwater to the surface throughout the year, resulting in perennial surface or near-surface water. These areas, referred to as Lower, Middle, and Upper Willows, form three of the most verdant riparian wetlands of the California desert (Warner and Hendrix 1985). Riparian vegetation covers approximately 120 acres at Lower Willows, 54 acres at Middle Willows, and 40 acres at Upper Willows.

History of the Use and Management of Coyote Canyon

Coyote Canyon was the site of several major Native American villages and cultural sites. Use of Coyote Canyon changed markedly after Europeans colonized North America. Over 200 colonists used the Anza Trail in the five years following Anza's initial pass through the canyon in 1773 (Lindsay 2001). Some of the first domestic cattle and horses in California also passed through Coyote Canyon. Cattlemen and homesteaders inhabited Coyote Canyon continuously from 1880 to the 1960s, with feral cattle remaining in the canyon until they were airlifted out in 1987 (Jorgensen 1989, Van Cleve et al. 1989). The first car traversed the canyon in 1924 and the De Anza Jeep Cavalcade traversed the canyon each year from 1949 through 1996 (Lindsay 2001). Between 1990 and 1995, public visitation to Coyote Canyon varied from 39,515 to 74,110 and averaged 55,175, although only a small percentage of these visitors traveled beyond Lower Willows (ABDSP Files).

As visitation rates for Coyote Canyon increased, public use policies gradually changed to heighten protection of the canyon's sensitive resources. Vehicle use in the canyon was essentially unrestricted until 1975, when a seasonal closure (June15-September 15) of the canyon was implemented to protect bighorn sheep summer watering sites. In 1987, a park-wide ban on green sticker vehicles (those licensed for off-road use only) was initiated. Another significant management action was taken with the completion of a bypass road at Lower Willows in 1988, created primarily to reduce impacts to endangered least Bell's vireo and bighorn sheep. The road through the canyon remained open until January 1993, when the road washed out and was subsequently closed for approximately two months.

The next major management action came in August 1995, when the California Department of Parks and Recreation updated their public use policies for Coyote Canyon. Their goal was to improve resource protection and recreational quality in recognition of increased visitor use in the Canyon. Changes to the public use polices were implemented through adoption of the Coyote Canyon Public Use Plan (California Department of Parks and Recreation 1995) which specified new management directives for the canyon. In developing the Public Use Plan, the Department considered a range of alternative management actions and held two public meetings to discuss these alternatives. Based on input from the public meetings, written comments, examination of all available information, and recommendations from other agencies, a preferred course of action (Section V; California Department of Parks and Recreation 1995) was selected.

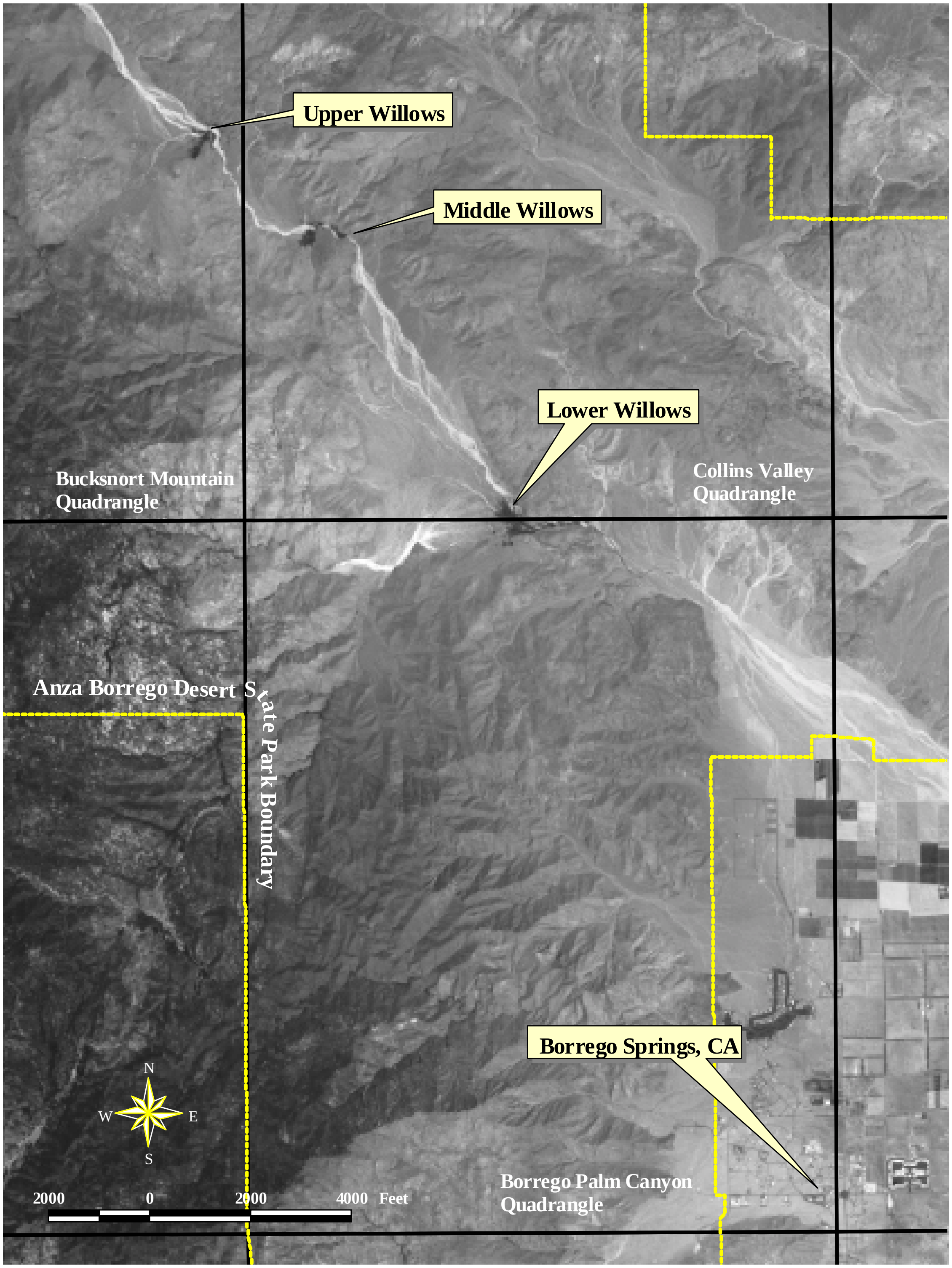


Figure 1. Coyote Canyon vicinity map (from California Department of Parks and Recreation 2002).

The Coyote Canyon Public Use Plan

The following is a summary of the management actions and related activities called for in the Coyote Canyon Public Use Plan (California Department of Parks and Recreation 1995).

1. *Middle and Upper Willows were closed to motorized vehicles.*
   At the southern or downstream end of Middle Willows a fence barrier to vehicles was constructed across the wash. This 4-wire strand fence is approximately 315 feet long and 5 feet high. The fence was built according California Department of Fish and Game standards to reduce the likelihood of injuring bighorn sheep. An opening in the fence acceptable for equestrians, hikers, and mountain bikers was installed where the trail and fence meet. A fence barrier to vehicles was also constructed at the upstream end of Upper Willows. This fence extends approximately 320 feet from bank to bank across the wash.

2. *Motorized vehicle access from the upstream end of Upper Willows near Bailey's cabin to the north boundary was maintained on a trial basis.*
   Signs warning of rough road conditions on the Turkey Track road were installed at the northern entrance to the Canyon. Vehicle access to Upper Willows from the north was maintained from October 1 to May 31 of each year.

3. *The three-month seasonal canyon-wide closure for all users was extended by 30 days, resulting in closure of the canyon from June 1 through September 30.*
   Signs stating the new seasonal closure dates were installed at the both ends of the closure area. Park rangers regularly patrolled portions of Coyote Canyon to enforce the closure.

4. *Camping in the three main oases (Lower, Middle, and Upper Willows) was prohibited.*
   Camping was eliminated along the length and width of the oases at Lower, Middle and Upper Willows. Open camping was allowed away from the oases, and the limits of open camping were marked with signs at the upstream and downstream ends of all three oases.

5. *The hiking and horse trail through Middle and Upper Willows was maintained to provide through-canyon access (October 1 to May 31).*
   The trail remained open and was realigned wherever the road was eliminated. Trail realignment was accomplished using methods described in the Trails Management Guidelines provided in Appendix A of the Coyote Canyon Public Use Plan (1995).

6. *The main hiking and horse trail through Middle and Upper Willows was opened to mountain bikes, providing through-canyon access for all non-motorized uses (October 1 to May 31).*
   Because there are no alternative trails for mountain bikes traveling the length of Coyote Canyon, an exception to Park policy was made to allow bike use on the motor vehicle road and hiking trail.

7. *Regulations and laws governing aircraft use in Wilderness Areas within Coyote Canyon were enforced.*
   Geographic Information Systems (GIS) coverages indicating flight paths and frequencies for all military flight routes in the Coyote Canyon area were plotted to assess their proximity to sensitive resources. Requests were made to reduce, modify, or eliminate flights over the most sensitive areas, and ABDSP personnel established relationships with the Desert Managers Group - Military Overflight Working Group.

8. *Major exotic flora and fauna were controlled.*
   Major exotic (non-native) flora and fauna identified within Coyote Canyon include tamarisk (*Tamarix ramosissima*), cowbirds (*Molothrus ater*), and feral horses (*Equus caballus*). The following are brief reports on efforts to control or remove these major exotic species in the canyon.

Tamarisk

Tamarisk or Saltcedar, a tree native to Africa, India, and Asia Minor, has been planted in arid or semi-arid habitats world-wide for windbreaks, fuel, fence posts, and soil stabilization (D'Antonio and Dudley 1997). Dudley et al. (2000) described the invasion of tamarisk as possibly one of the worst ecological disasters to befall riparian ecosystems in the western U.S. Tamarisk displaces or replaces native plant communities because it extracts large amounts of water through its deep roots and eventually lowers the water table. Tamarisk thickets are highly flammable and burn more frequently than the native vegetation (Busch and Smith 1992). Tamarisk-fueled fires often kill the associated native cottonwood trees, damage native riparian vegetation, and degrade wildlife habitat (Paxton et al. 1996). Tamarisk also reduces habitat quality for birds because of its relatively depauperate associated insect assemblage; few native insects feed directly on tamarisk (Liesner 1971; Dudley et al. 2000).

Removal of tamarisk from Coyote Canyon is particularly important for the protection of native birds and riparian vegetation. The Departmental Directives on Resource Management for the California State Park System (section 1831.1, policy no. 34) call for the systematic removal of aggressively invading exotic vegetation (i.e., tamarisk) when it becomes established anywhere in the park. Federal recovery plans for both the least Bell's vireo and bighorn sheep in the Peninsular Ranges also call for the removal of tamarisk to improve habitat quality for these species (USFWS 1998, USFWS 2000). The following is a brief summary of tamarisk removal efforts in Coyote Canyon. In general, tamarisk removal efforts began in 1988, approximately one-third of the removals were done in 1994-1996, and the remaining two-thirds of the work was accomplished in 2001 (P. Jorgensen personal communication). All areas invaded by tamarisk require annual maintenance to prevent and control reinfestation.

Lower Willows

The first documented phase of tamarisk removal efforts (treatment) in Lower Willows began in 1988 (Van Cleve 1989), with additional work in 1994-1996 (Van Diepen 1996). No evidence of new tamarisk growth was found at the first stream crossing in Lower Willows during 2000. The area between the second and third stream crossings was heavily infested with tamarisk, but was effectively treated during December 2001. Mature stands of tamarisk were found in the area between the Third Crossing and Collins Valley in 2000 (S. Martin, personal communication).

Collins Valley and Middle Willows

Collins Valley has been treated for tamarisk annually since 1997. Middle Willows has been a high focus area since it was treated before 1996 and is virtually tamarisk-free (S. Martin, personal communication).

Upper Willows, Nance & Tule Canyons

Extensive treatments have been conducted in Upper Willows since 1997 and this area is virtually tamarisk free. Nance Canyon contains tamarisk and it has not been treated since 1996. Tule Canyon was extensively treated before 1996, but became reinfested and tamarisk eradication efforts were reinstated in February 2002.

Brown-headed Cowbirds

Brown-headed cowbirds are nest parasites (they lay their eggs in other bird's nests). Cowbirds were not documented in San Diego County until 1896, when the first one was recorded in Borrego Springs (Unitt 1984). Cowbird numbers have steadily increased as habitat has been converted to favorable cowbird habitat (e.g., agricultural fields and dairies). Where their range overlaps those of smaller passerines in low-elevation riparian habitats, they affect willow flycatchers, Bell's vireo, yellow warblers, and goldfinches (Small 1994). Nest parasitism by cowbirds is a well-documented limiting factor on both

Table 1. Number of trap days, cowbirds removed, and cowbirds removed per day in Coyote Canyon 1996-2000 (Jorgensen 1996; Jorgensen and Jorgensen 1997, 1998, 2000; Wells and Kus 2001).

Year	No. trap days	Cowbirds removed	Cowbirds removed/trap day
1996	161	168	1.04
1997	138	115	0.83
1998	119	55	0.46
1999	118	82	0.69
2000	60	41	0.68

southwestern willow flycatcher (USFWS 1997) and least Bell's vireo nesting success and productivity (USFWS 1998). Recovery objective 1.5 in the Draft Recovery Plan for least Bell's vireo (USFWS 1998) calls for the continued removal of cowbirds from vireo habitat.

Brown-headed cowbirds were seen throughout the park during the least Bell's vireo survey in 1986 and 57% of the vireo nests were parasitized (Wier and Jones 1986). A cowbird removal project was implemented in Coyote Canyon in 1986. In 1988, 170 cowbirds were removed from Lower Willows and the Vern L. Whittaker Horse Camp (Griffith and Griffith 1988). Between 1996 and 2000, over 450 cowbirds were trapped and removed from Coyote Canyon (Jorgensen 1996; Jorgensen and Jorgensen 1997, 1998, 2000; Wells and Kus 2001; Table 1).

<u>Feral Horses</u>

The feral horse population inhabiting Coyote Canyon originated from domestic horses that escaped or were released from nearby ranches in the 1930s or 1940s. Although no systematic surveys for feral horses were conducted until April 2001, observations and occasional counts suggest the herd maintained itself at approximately 30-40 horses for at least the past decade (Department files; M. Jorgensen, personal communication).

Feral horses in Coyote Canyon trample and consume riparian vegetation at Middle and Upper Willows (California Department of Parks and Recreation 2002). They may also potentially interfere with bighorn sheep water use along Coyote Creek (USFWS 2000) and degrade amphibian habitat in the creek (Warburton and Fisher 2001, 2002). The Department has contracted a study investigating the impacts of feral horses on the Coyote Canyon ecosystem that will begin in the summer of 2002.

9. *Increase identification and monitoring of prehistoric and historic resources.*
   Several projects have focused on monitoring of prehistoric and historic archaeological sites. These include investigations by the Archaeological Research Unit of the University of California, Riverside, from 1994-1997, a study of cultural resources along proposed routes for a by-pass road above Lower Willows (Gallegos et al.1998), and a Cultural Deferred Maintenance Project: Anza-Borrego Desert State Park Records Search and Site Evaluation 2002 (#841-99-00233).

   Another recently funded project concerns the possible location of an important historical event: the 1851 Military Tribunal and consequent execution of four Indian men found guilty of participation in the famed Garra Revolt. Data collection for this project will continue in fall 2002.

10. *Increase monitoring of the desert bighorn sheep.*
    Monitoring of bighorn sheep in Coyote Canyon has been ongoing for over 30 years. Waterhole counts have been conducted in bighorn habitat throughout the park, including 6 areas in Coyote Canyon each summer since 1971. Bighorn in Coyote Canyon were fitted with radio telemetry collars containing mortality sensors in 1993 (n = 9), 1997 (n = 5), and 1999 (n = 3). Radiocollared bighorn were regularly monitored to determine survival rates and causes of mortality (Hayes et al. 2000).

Helicopter surveys of bighorn sheep have been conducted throughout ABDSP every other year since 1994 to monitor their distribution and abundance (Rubin et al. 1998).

In 2000, the Department contracted monitoring of bighorn sheep as part of a large-scale investigation of mountain lion, deer, bighorn sheep, and human interactions in ABDSP and Cuyamaca Rancho State Park. In 2001, 8 bighorn (3 of these bighorn were previously collared) in Coyote Canyon were fitted with Geographic Positioning System (GPS) collars, which automatically collected data on the location of the animals up to 36 times per week. These bighorn are also being monitored to determine survival rates.

Monitoring Associated with the Coyote Canyon Public Use Plan

Adaptive management is the process of implementing policy decisions as scientifically driven management experiments to test management plans, and using the resulting information to improve existing plans (Noss and Cooperrider 1994). Using adaptive management, the Department committed to monitoring six parameters in Coyote Canyon to assess the effectiveness of the Public Use Plan management actions for improving recreational quality and resource protection. Monitoring over the 5-year period from 1996 to 2001 focused on the following:

(1) Conducting a visitor use survey regarding the impacts of plan implementation on recreational quality;
(2) Monitoring changes in the profile of the streambed in Middle and Upper Willows where motor vehicles drove in the creek, and monitoring changes in the streamflow regime and channelization after vehicle exclusion and episodic storm events;
(3) Monitoring the amount of revegetation of riparian areas where past motor vehicle use had reduced vegetative cover to 0-20%;
(4) Monitoring the changes in amphibian use of aquatic canyon bottomlands and the use of Middle and Upper Willows by bighorn sheep, least Bell's vireo, and southwestern willow flycatcher.

If results from the 5-year monitoring studies failed to demonstrate overall improved recreational quality or resource protection and health, the Department agreed to give serious consideration to modifying the Plan to increase vehicular access in the Canyon. This report provides a summary and synthesis of the monitoring studies conducted during 1996-2001 and includes relevant monitoring data collected prior to 1996 when appropriate. This data was used to determine whether there was evidence of improved (1) recreational quality, (2) resource protection, or (3) resource health. Each species or topic was considered separately and then results were synthesized in the concluding section.

Understanding Coyote Canyon's use and management history is important for accurate interpretation of results from recent monitoring studies. Given the long history of modifications in public use in the canyon, changes in resource status may reflect management actions taken prior to 1996, and/or the cumulative effects of improved resource protection. Furthermore, five years (the monitoring period) is a short length of time to detect recovery in a desert system. Because mineral cycling rates in deserts are high relative to the input and output rates, desert ecosystems are slow to recover following disturbance (Jordan et al. 1972, Bolling and Walker 2000). Roads and traffic have detrimental effects on soil nutrients and cycling (Webb and Wilshire 1980, Knapp 1991), which can indirectly affect plant community development for many years following disturbance (Bolling and Walker 2000).

COYOTE CREEK

Introduction

Coyote Creek runs northwest to southeast, bisecting Coyote Canyon with the Santa Rosa Mountains to the north and the San Ysidro Mountains to the south. Intermittent and ephemeral for much of its length, the creek passes three areas (Lower, Middle and Upper Willows) where bedrock forces the groundwater upward to create perennial surface or subsurface flows. This section of the report focuses on changes to the physical profile of Coyote Creek before and after implementation of the Coyote Canyon Public Use Plan.

The Coyote Canyon watershed drains approximately 95, 102, and 154 square miles at Upper, Middle, and Lower Willows respectively (Matthews 1995). From 1951 to 1992, average daily streamflow in the creek measured at Lower Willows was relatively stable and ranged from 0.5 cubic feet per second (cfs) to 4.9 cfs, with the exception of 1980, when the average was 14.8 cfs. In contrast, peak annual flows fluctuated widely from 3 cfs to 3,890 cfs. Large-scale storm events occurred in the canyon approximately every 20-25 years (Matthews 1995). Episodic, large-magnitude storm events such as these dominate geomorphic processes in arid regions such as Coyote Canyon (Chorley et al. 1984).

Major floods can have significant impacts by destroying vegetation, permitting re-establishment of buried seeds, and altering the morphology of the floodplain (Keddy 2000). Ecologically healthy stream systems continuously change the shape of the streambed and riparian zone and the topography of the floodplain (Muhar and Jungwirth 1998). These dynamics control the input and removal of nutrients and organic matter, and their temporal and spatial diversity lead to a high density of biologically diverse transitional habitats (Schiemer and Zalewski 1992, Moulton 1999). Maintaining the integrity of the streambed and natural disturbance regimes is important for maintaining biological diversity (Pickett and Thompson 1978, Hobbs and Huenneke 1992).

Prior to the road closure in 1996, motor vehicles traveled through and across the streambed in both Middle and Upper Willows. Vehicles can have significant detrimental impacts on streambed structure and shape, riparian vegetation and soil, and water quality (Snyder et al. 1976, Webb and Wilshire 1978, Lenat et al. 1981, Hinckley et al. 1984, Brown 1994, D'Antonio and Dudley 1997). Concentrating water flow in vehicle tracks causes stream channel incision (narrowing and deepening of the channel) and accelerates erosion. Channelization also simplifies the stream by reducing stream meandering and the number of channels, and increasing the slope, flow velocities, and erosional energy of the river. Stream channel incision lowers the water table and reduces subsurface water availability. In October 1992, motor vehicle use at Middle Willows had deeply incised the streambed by over 1.5 meters, resulting in lowering of the water table by over one meter (Matthews 1995).

Approach

The status of the Coyote Creek streambed prior to the implementation of the Public Use Plan was assessed using data and analyses from Matthews (1995). Matthews used photographs, hydrologic data, and field surveys conducted from 1991 through 1995 to describe the geomorphology of the stream channel and evaluate the effects of motor vehicle use on the stream.

Data and analyses provided by the California Department of Parks and Recreation (2002) were examined to identify changes in the streambed that occurred following closure of the road. Streambed data (photographs, bank number, channel depth, surface water) were collected each spring and summer from 1997 through 2001 along seven line transects (Figure 2) crossing the Coyote Creek floodplain and streambed in Middle and Upper Willows. Photographs taken of the streambed twice annually documented visible changes in the previous road. For each transect, stream bank number was calculated as the number of banks greater than or equal to 10 cm in depth per transect length. Channel depth was measured as the vertical distance between the stream channel bottom and the nearest level portion of the floodplain.

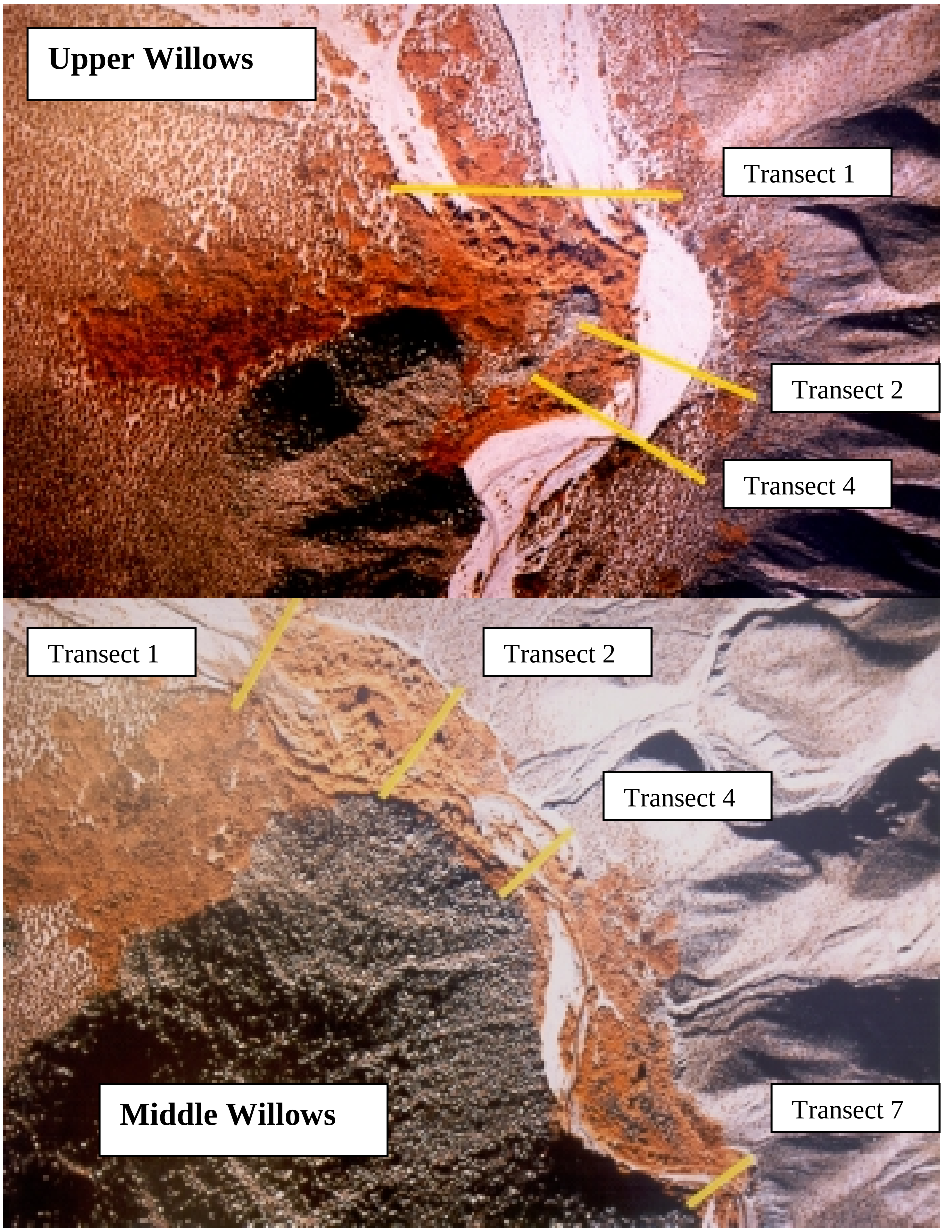


Figure 2. 1996 Aerial photographs of Upper and Middle Willows showing the seven transects used for vegetation and streambed monitoring by the California Department of Parks and Recreation (2002).

Surface water frequency was measured as the number of hits of surface water (at 1.0 meter intervals) across a transect divided by the transect length. Streambed data from each year was compared to data from the initial year of monitoring (1997) to identify changes at each of the seven transects. Results were then averaged across transects.

Water quality in Coyote Creek was evaluated using data presented by Warburton and Fisher (2002). In 2001, water samples were collected from Upper Willows, Middle Willows, North Fork Alder Canyon, and South Fork Alder Canyon. Water quality variables were measured using a YSI Handheld Dissolved Oxygen Conductivity, Salinity and Temperature System; an Oakton TDSTester 10; and an Oakton PHTester 2. Changes in water quality over time could not be assessed since samples were collected and analyzed only in 2001.

Results and Discussion

Photographs taken by Matthews (1995) documented the effects of vehicles on the streambed of Coyote Creek prior to the road closure in 1996. Figures 3a-c show examples of bank chiseling, channel incision, and increased water turbidity. Bank chiseling occurred when vehicles crossed the streambed at an angle breaking down the banks on either side of the channel. Channel incision occurred when the road and tire track ruts ran through the streambed. Vehicles passing through the streambed also disturbed bottom sediments and increased the turbidity of the water.

A series of photographs taken at the same location in Middle Willows illustrate changes in the stream channel associated with motor vehicle use before and after the major flood of January 1993 (Figure 4). In October 1992, the stream channel was deeply incised (by over 1.5 meters) and had eroding banks where the road transversed the streambed. This incision lowered the water table by over one meter and thereby decreased the amount of subsurface water available to vegetation on adjacent banks (Matthews 1995). The major flood of January 1993 dramatically altered the geomorphology of the creek. Sediment from this flood filled the previously incised stream channel and created a wide, flat channel (Figure 4, March 1993). Eleven months later (Figure 4, December 1993) there was a well-defined channel and vegetation had emerged except where the reestablished road prevented its growth. The deeply incised stream channel noted in 1992 was the result of the disturbance incurred since the last major flood in 1980. The 1980 flood was the largest flood recorded in the canyon between 1951 and 1992, and it likely had effects similar to those of the 1993 flood in essentially removing visible evidence of the road. However, these flood events may have been more effective in creating habitat diversity if the streambed channel had not been incised from motor vehicle use (Matthews 1995).

Vehicles continued traveling through the streambed in Middle Willows for 3 years after the flood, until the road was closed in 1996. California Department of Parks and Recreation (2002) initiated streambed monitoring in 1997 to determine the effects of the management changes described in the Public Use Plan. Evaluation of the number of stream banks in Middle and Upper Willows showed that the number increased gradually between 1997 and 2001 (Figure 5). In other words, the water flowed through an increasing number of channels (two banks per channel) over time. There were significantly more banks in spring 2000 than in spring 1997, but the number of banks in 2001 was not statistically different from 1997. Although the overall upward trend in number of banks in spring and summer appeared similar, none of the increases in summer data were statistically significant. Channel depth data appeared to show an inverse relationship with the number of channel banks over the monitoring period (Figure 6). However, there were no significant changes in stream channel depth when subsequent years were compared to 1997 levels. Percent cover of surface water was variable and there was no clear trend in the data. This result may have been influenced by the low level of precipitation received during the monitoring period. Water quality variables were all within the normal ranges (Warburton and Fisher 2002).

Qualitatively, it was clear from photographs (Matthews 1995) that the major flood in 1993 substantially altered the streambed and associated motor vehicle impacts. However, the diversifying effects of the flood were limited by streambed incision, and incision of the channel through Middle Willows reoccurred soon after the 1993 flood (Matthews 1995). Visible traces of the road and motor vehicle use subsided following implementation of the Public Use Plan (Figure 7).

Conclusions

Detrimental impacts associated with motor vehicle travel through streambeds have been thoroughly documented in the scientific literature (Snyder et al. 1976, Webb and Wilshire 1983, Trombulak and Frissell 2000) and by monitoring conducted in Coyote Canyon (Vyverberg 1991, Matthews 1995). Monitoring results provided evidence of improved streambed conditions in that increased incision and erosion were not detected, as would have occurred if vehicle use of the streambed had continued. Closure of the road through Middle and Upper Willows increased the level of resource protection in Coyote Canyon. This improved the status and integrity of the streambed, a factor of critical importance to the ecological health of the canyon.

Although major floods remove many signs of motor vehicle use, the diversifying function and long-term effects of floods are compromised by streambed incision. Restoring the natural physical structure of the Coyote Canyon streambed will maximize the diversifying effects of future flood events in the canyon (Vyverberg 1991, Matthews 1995). This will help create and maintain a variety of habitats for plants and animals (Moulton 1999).

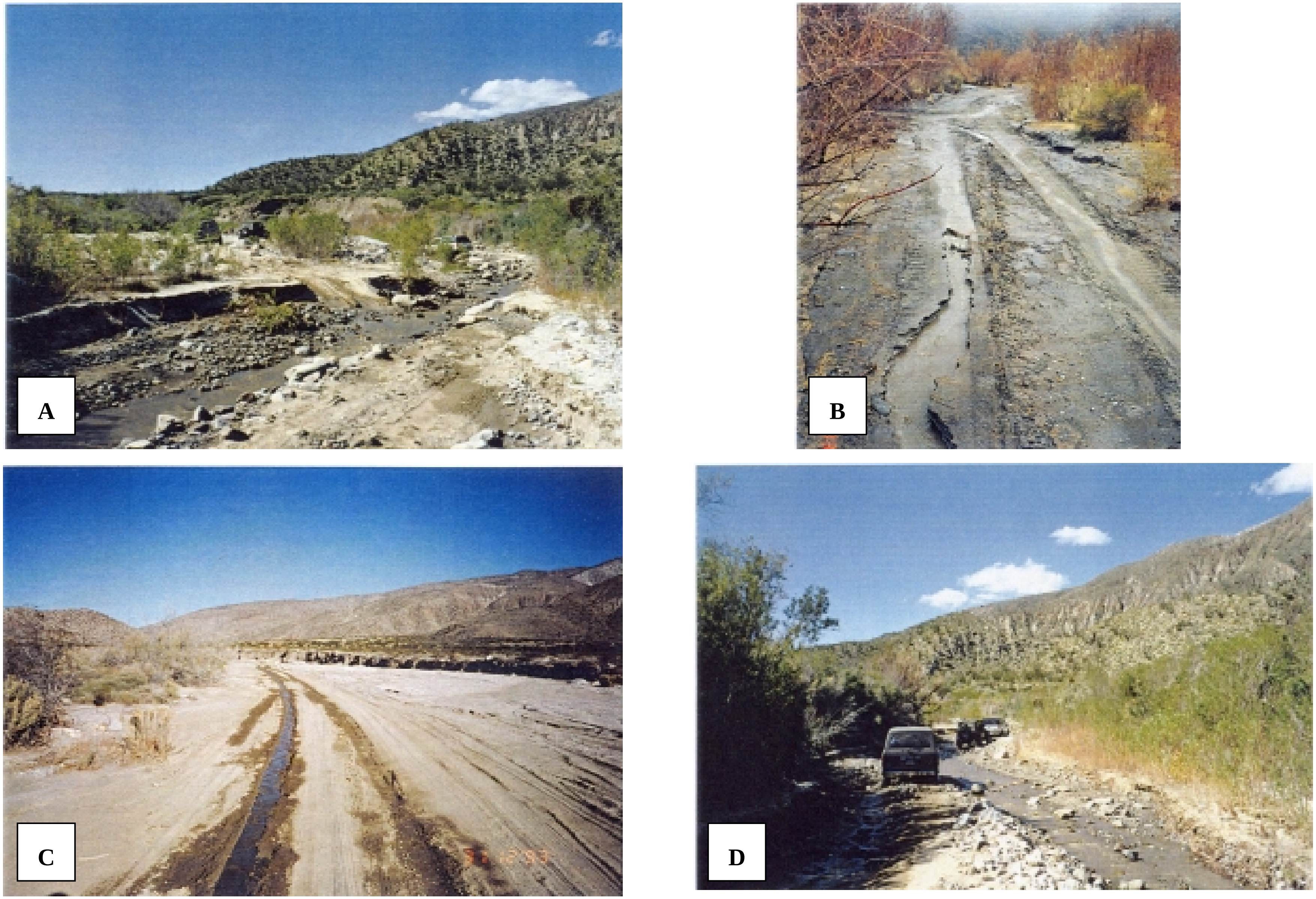
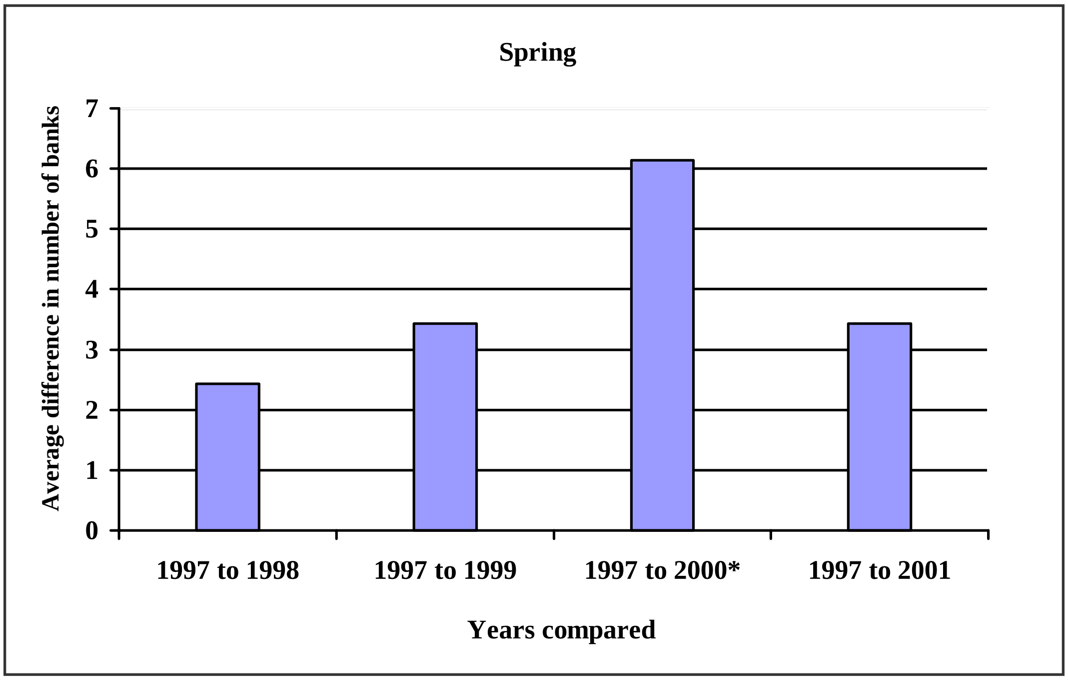


Figure 3. Impacts of off-highway vehicles in Middle Willows (Figure 59 from Matthews 1995). Clockwise from left to right: A) bank chiseling; B) and C) early stages of channel incision resulting from vehicle passage; D) section of Coyote Creek before the January 1993 flood.

Figure 4. Channel changes pre and post-January 1993 flood near the transects. Photos taken October 1992, March 1993, December 1993, and March 1995 (Figure 37 from Matthews 1995).



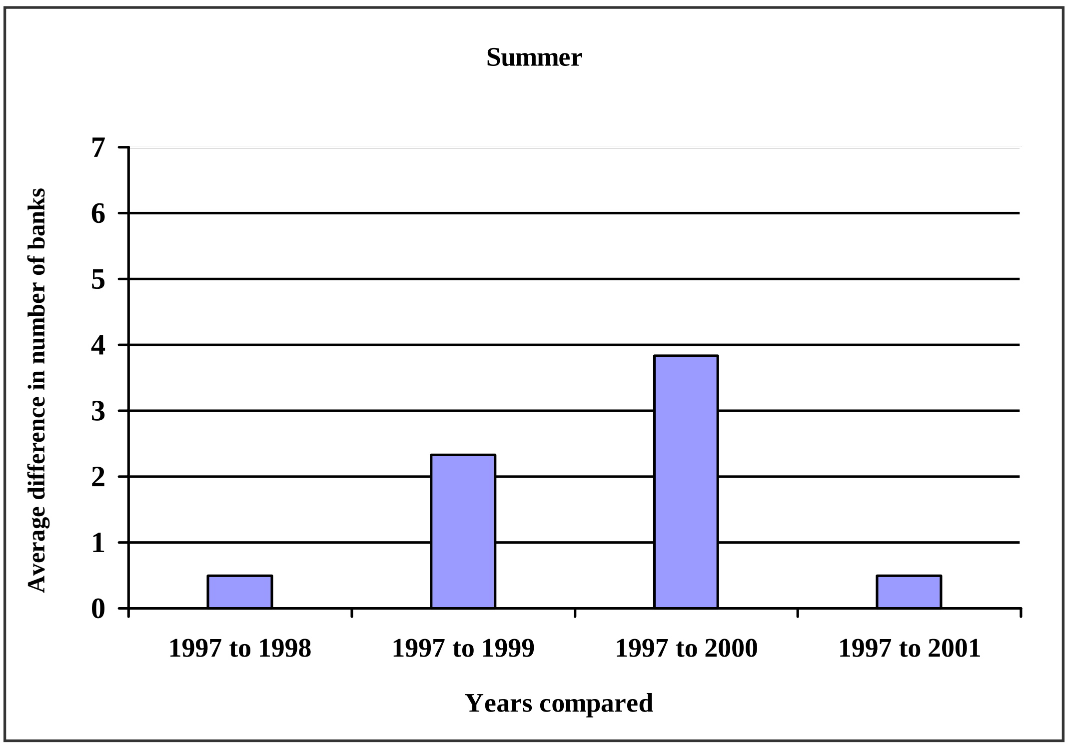
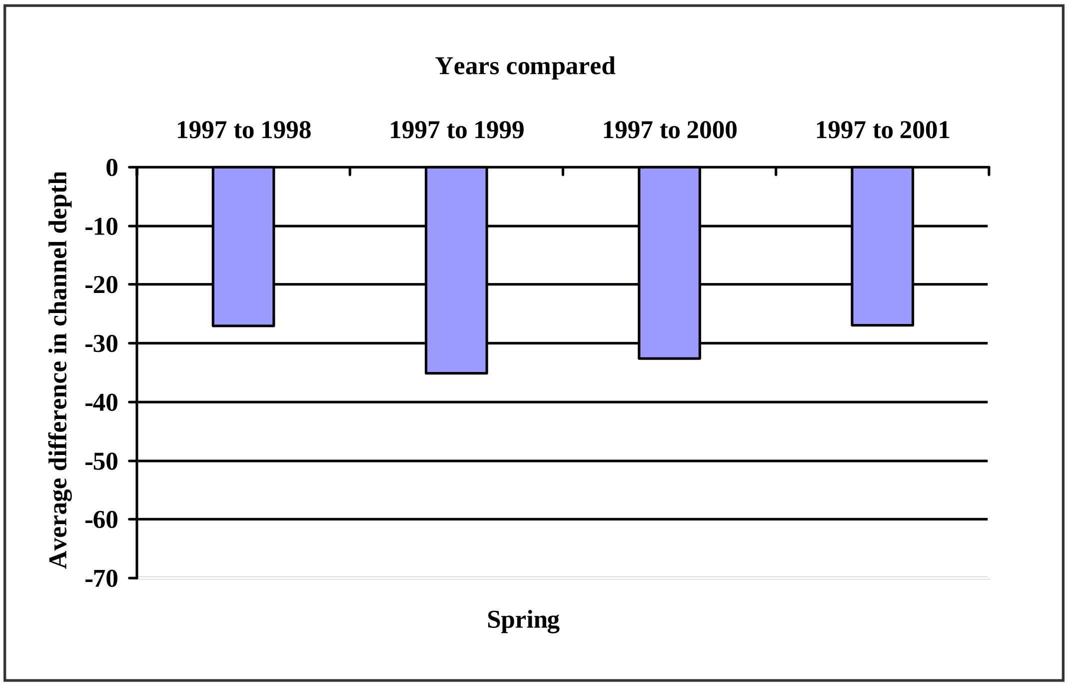


Figure 5. Average difference in the number of channel banks in Coyote Creek. Comparisons were made between 1997 and each subsequent year (1998-2001) for both Spring and Summer sampling dates. For example, there were six more banks (or three more channels) when Spring 1997 was compared to Spring 2000. Averages were taken across 7 transects. An asterisk indicates significant differences between years. (From California Department of Parks and Recreation 2002).



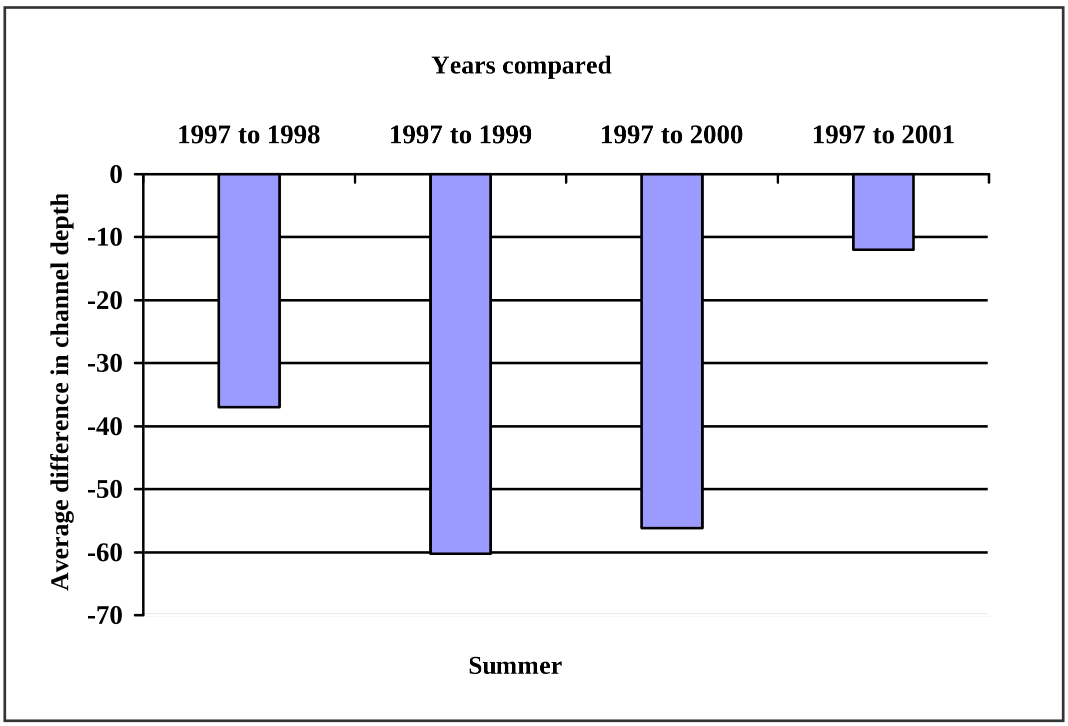


Figure 6. Average difference in stream channel depth (in centimeters) in Coyote Creek. Comparisons were made between 1997 and each subsequent year (1998-2001) for both Spring and Summer sampling dates. For example, the average channel depth was 30 cm less in Spring 2000 than in Spring 1997. Averages were taken across 7 transects. No significant differences were found. (From California Department of Parks and Recreation 2002).

VEGETATION

Introduction

The biological importance of Coyote Canyon is largely a function of the perennial surface water and islands of tall-structured wetland vegetation in Lower, Middle and Upper Willows. Riparian habitat contains greater niche diversity, micro-climates, nutrients and biological diversity than other more xeric habitats. In the arid Southwest 77% and 51% of all breeding birds are partially or completely dependent on riparian habitat, respectively. Additionally, 83% of native amphibians and 40% of all native reptiles in California require riparian habitat during all or part of their life cycle (Brode and Bury, in Warner and Hendrix 1984). The Willow areas in Coyote Canyon are “hotspots” of biodiversity and their maintenance is critical to the integrity of the Coyote Canyon ecosystem.

Five sensitive habitat or vegetation types occur in Coyote Canyon, including: Desert Fan Palm Oasis Woodland, Mesquite Bosque, Mojave Riparian Forest, Sonoran Cottonwood Willow Riparian Forest, and Sonoran Riparian Woodland. Several of these riparian vegetation associations have been recognized for their rarity and sensitivity by the state of California. Lower and Middle Willows are identified as Significant Natural Areas (SNA) in the California Department of Fish and Game’s Natural Diversity Data Base because they contain sensitive Desert Fan Palm Oasis Woodland, Sonoran Riparian Forest, and nesting habitat for least Bell’s vireo. Upper Willows contains the same resources but was not designated as an SNA due simply to an oversight (California Department of Parks and Recreation 1995). All riparian habitat in Coyote Canyon is considered wetlands and is protected under the Keene-Nejedly California Wetlands Preservation Act of 1976.

There are a variety of vegetation types both within riparian areas, and canyon wide. The tall-statured willow-dominated vegetation in Coyote Canyon is largely dominated by red willow (*Salix laevigata*), accompanied by arroyo willow (*Salix lasiolepis*), cottonwood (*Populus fremontii*), desert fan palm (*Washingtonia filifera*), and desert grape (*Vitis girdiana*). Perennial shrub species such as mulefat (*Baccharis salicifolia*), narrow-leaved willow (*Salix exigua*), and arrow weed (*Pluchea sericea*) are mixed with willow-dominated vegetation. Wetter portions of the wetlands are dominated by annual and perennial herbs such as cattail (*Typha latifolia*), tule (*Scirpus americanus*), and scratchgrass (*Muhlenbergia asperifolia*) (California Department of Parks and Recreation 2002).

The boundary between wetland and upland habitats in Coyote Canyon is typically defined by stands of honey (*Prosopis glandulosa*) and screw-bean (*P. pubescens*) mesquite (California Department of Parks and Recreation 2002). These species have deep rooting systems and are able to better access subsurface moisture. Higher areas within the floodplain support sparse shrublands of low-statured drought-deciduous species such as alkali goldenbush (*Isocoma acradenia*), broom lotus (*Lotus rigidus*), and desert baccharis (*Baccharis sergiloides*) (California Department of Parks and Recreation 2002).

It is the diversity and spatial arrangement of vegetation associations (i.e., wetland vegetation, mesquite bosque, dry wash vegetation, creosote bush scrub) in the Canyon, in combination with perennial surface water, that allow for a dense array of habitats and wildlife species. Vegetation is a key component of riparian habitat. It provides structure and cover for animals, shade which influences water temperature, and plays an important role in nutrient cycling and soil stabilization. This section of the report provides an assessment of changes in vegetation structure and cover that occurred from 1997 through 2001 following implementation of the Public Use Plan in 1996.

Approach

Data and analyses presented in California Department of Parks and Recreation (2002) were used to evaluate changes in the vegetation found at Upper and Middle Willows from 1997 through 2001. Data collection focused at two spatial scales: within the former road, and within the entire floodplain (California Department of Parks and Recreation 2002). Data on vegetation height and percent cover were collected by placing a one square meter quadrat every five meters within the former road or active stream channel along seven transects in Upper and Middle Willows (Figure 2). To quantify vegetation height, woody species within the quadrats (n = 34) were assigned to one of three height classes: A (<1 meter), B (1-3 meters), and C (>3 meters). The frequency of each height class was calculated as the number of plants per height class in a quadrat, divided by the number of quadrats per transect. To quantify vegetation abundance, each quadrat was evaluated to determine the amount covered by shrubs, trees, or herbs. Likewise, each quadrat was evaluated to estimate the percent cover of bare ground versus plant litter (dead plant material). Photographs of vegetation were taken at 50-meter intervals in four compass directions along the streambed in both Upper and Middle Willows in the spring and summer of each year.

Floodplain-wide data were also collected along the seven point-intercept transects depicted in Figure 2. Vegetation structure or height was quantified by recording the frequency of live plant material "hits" in three height classes: A (<1 meter), B (1-3 meters), and C (> 3 meters) at 1-meter ground intervals. Vegetation abundance was estimated using the frequency of hits of live plant material of a particular plant species at 5-meter ground intervals along the transects. Qualitative data were collected in the form of photographs taken in the four cardinal directions at 20-meter intervals along each of the seven transects.

Aerial photographs were taken of Middle Willows in 1995, 1997, and 2000 and photo interpretation was used to classify the areas surrounding the road as wetland vegetation or dry wash/unvegetated wetland. Comparisons were then made using GIS analyses to determine if the area covered by vegetation increased or decreased over time.

Results and Discussion

Significant increases in the structure (height) of vegetation within the former road were detected over the 5-year monitoring period (Figures 7 and 8). Vegetation in height class B (1-3 meters) increased significantly between spring 1997 and spring 2000, and height class C (> 3 meters) increased significantly from 1997 to 2000 and 2001. These increases were mostly a result of increases in mature shrubs such as mulefat and narrow-leaved willow, or sapling tree species. In contrast, there were no statistically significant changes in floodplain-wide vegetation height.

Shrub cover or abundance within the former road also increased significantly from the spring 1997 to spring 2000 and 2001 monitoring periods (Figure 9). This was consistent with the height-class data, suggesting that the increase in vegetation 1-3 meters tall was due to the growth of shrub species. Percent cover of herbs increased significantly from spring 1997 to spring 2000, but not 2001. Herb cover can be strongly influenced by annual precipitation and the presence of surface or near surface water. Percent cover of trees did not change, perhaps because trees require a longer time period to respond to management or environmental changes. When herb, shrub, and tree cover data were evaluated on a floodplain-wide basis, there were no statistically significant changes detected.

One of the more pronounced changes was the significant decrease in bare ground in 1999-2001 and the corresponding increase in litter within the former road in the same years (Figure 10). Increased organic matter (leaf litter) is important for soil development and as a nutrient source for aquatic species (Schade and Fisher 1997, Rosi-Marshall and Wallace 2002).

In analyzing photos from transects in the former road and floodplain-wide, California Department of Parks and Recreation (2002) evaluated each photo series for clear evidence of increases or decreases in shrub or tree cover between sampling periods of the same season. Herbaceous species were not considered because they were too variable to effectively classify over time. Taking a conservative approach, the authors recorded increases in vegetation only if the increase in any year was sustained until the last year of monitoring (2001). Furthermore, increase in the growth of a single individual was not considered an increase in cover.

Figure 7. Photographs taken in the summers of 1997 – 2001 from a transect showing the former road through Middle Willows in Coyote Canyon.

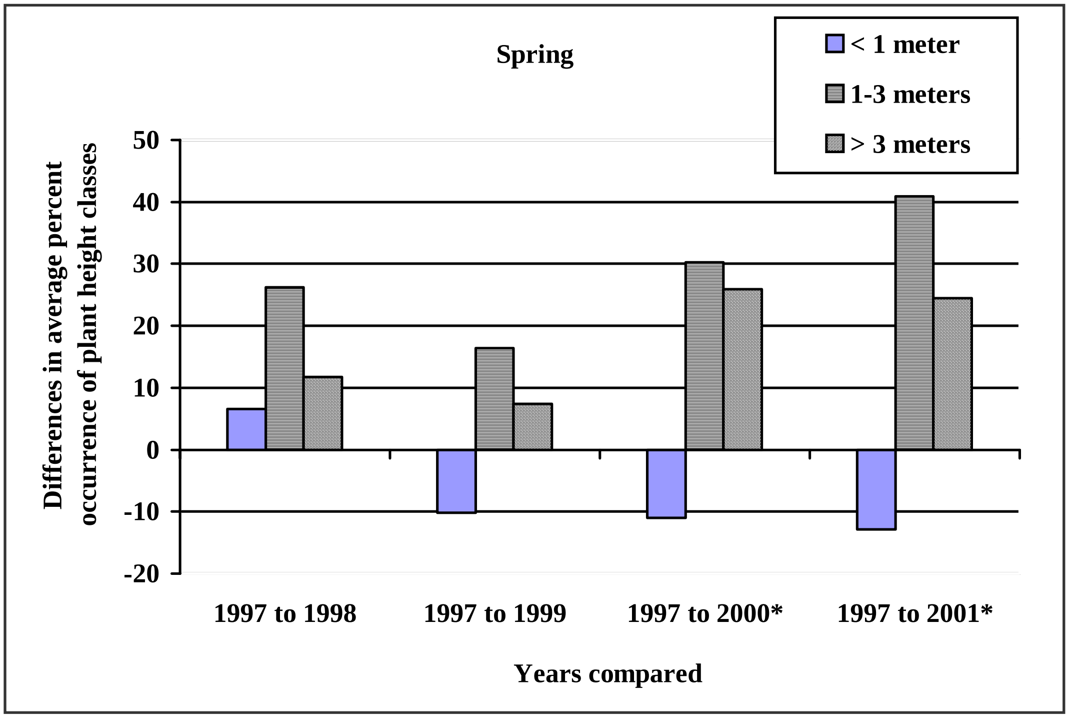
Summer 1997

Summer 1998

Summer 1999

Summer 2000

Summer 2001



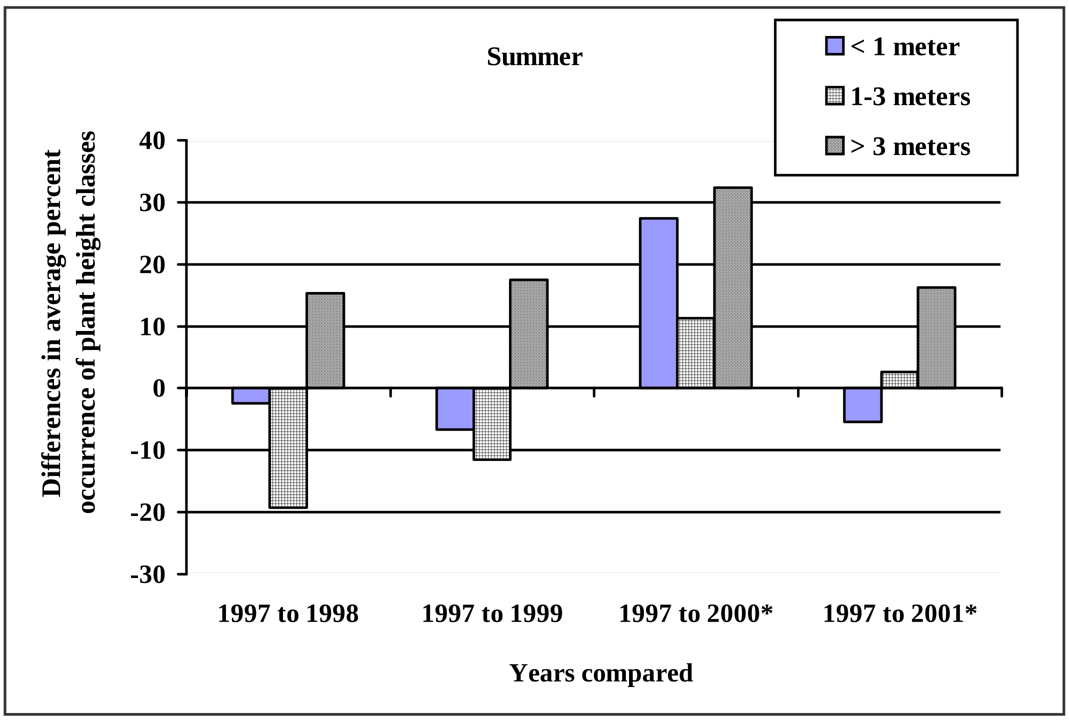


Figure 8. Differences in the average percent occurrence of woody plants in each of three height classes in Coyote Creek. Comparisons were made between 1997 and each subsequent year (1998-2001) for both Spring and Summer sampling dates. Averages were taken across 7 transects. An asterisk indicates significant differences between years in at least one height class. (From California Department of Parks and Recreation 2002).

Table 2. Changes in vegetation acreage floodplain-wide and within the former road at Middle Willows in 1995, 1997, and 2000. Compare to Figure 12. (From California Department of Parks and Recreation 2002).

	1995 acres (%)	**1997 acres (%)**	**2000 acres (%)**
Wetland vegetation (in former road)	0.33 (50.8)	0.32 (49.2)	0.50 (76.9)
Dry wash or unvegetated (in former road)	0.32 (49.2)	0.33 (50.8)	0.15 (23.1)
Wetland vegetation (floodplain-wide)	21.02 (78.8)	21.83 (81.9)	23.90 (89.6)
Dry wash or unvegetated (floodplain-wide)	5.65 (20.2)	4.84 (19.1)	2.77 (11.4)

Documentation of the growth of several individuals or recruitment of new individuals was required in order for a photo series to be classified as an increase. Decreases were noted where vegetation decreased in cover from that present in first year (Spring 1997). Increases or decreases were only noted in photo series where there was a common reference feature. If photos had no common reference feature, were obviously not registered, or were from a misleading perspective, they were classified as "not observably different." This data classification scheme may have biased the results of this analysis by inflating the "no change" category.

Despite these caveats, photographs taken along transects within the former roadbed corroborate the findings of increased live plant material and increased litter cover (Figure 11). Both spring and summer road transects had more photo series showing increases in tree or shrub cover than decreases. Photo series showing decreases involved either the mortality of a moderate sized tree or dead seedlings. There were a total of 180 photograph series taken along the floodplain-wide transects. Of the data collected during the spring, 19 transects showed evidence of an increase, 5 showed evidence of a decrease, and the remaining photos showed either no change or were not registered correctly and the results were indiscernible. Floodplain-wide transects showed fewer increases than transects within the former road, where the spring data showed 35 increases and 5 decreases.

Analysis of aerial photographs revealed that substantial revegetation occurred in Middle Willows between 1995 and 2000 (Table 2, Figure 12). In 1995, just two years after the major 1993 flood and while vehicles were still allowed to travel through Middle Willows, wetland vegetation cover in the road alignment was estimated at 0.33 acre. By 1997, shortly after the road closure, wetland vegetation had decreased to 0.32 acre. However, by 2000 vegetation in the former road alignment had increased to 0.50 acre. This 28% increase in vegetation cover within the former road indicates a marked recovery of conditions and habitat in Middle Willows. On a floodplain-wide basis, vegetation cover increased as well, but at a slower rate than in the vicinity of the former road. Floodplain-wide vegetation cover increased 3.1% (0.8 acre) by 1997, and an additional 7.7% (from 21.8 acres to 23.9 acres) by 2000 (Table 2)

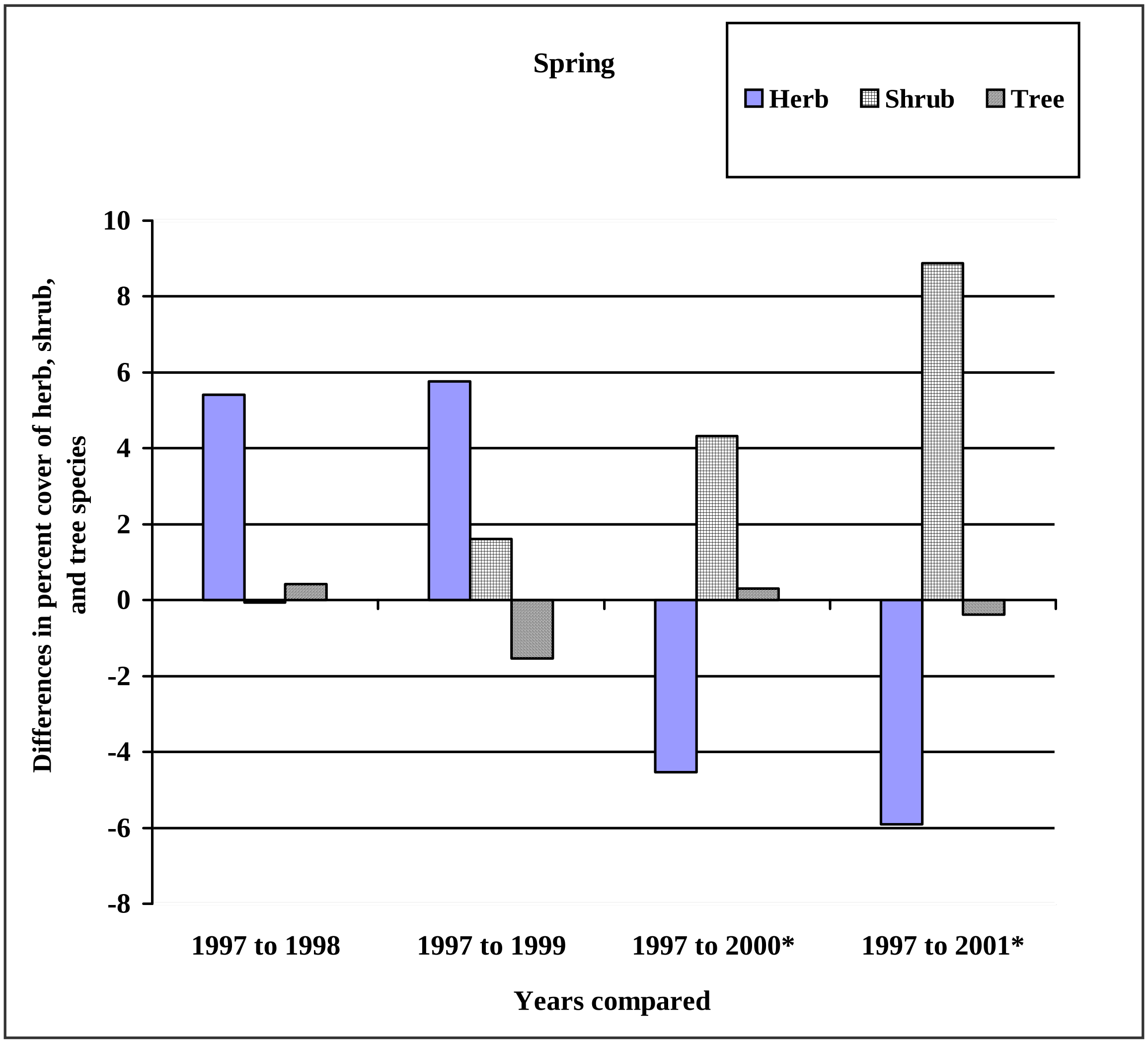


Figure 9. Differences in percent cover of herb, shrub, and tree species in transect quadrats in Coyote Canyon. Comparisons were made between 1997 and subsequent years (1998-2001). Percent cover was averaged across 7 transects. Herb cover was expressed as percent foliar cover; shrub and tree species cover was expressed as percent basal area. Asterisks indicated significant differences in percent cover of at least one species. (From California Department of Parks and Recreation 2002).

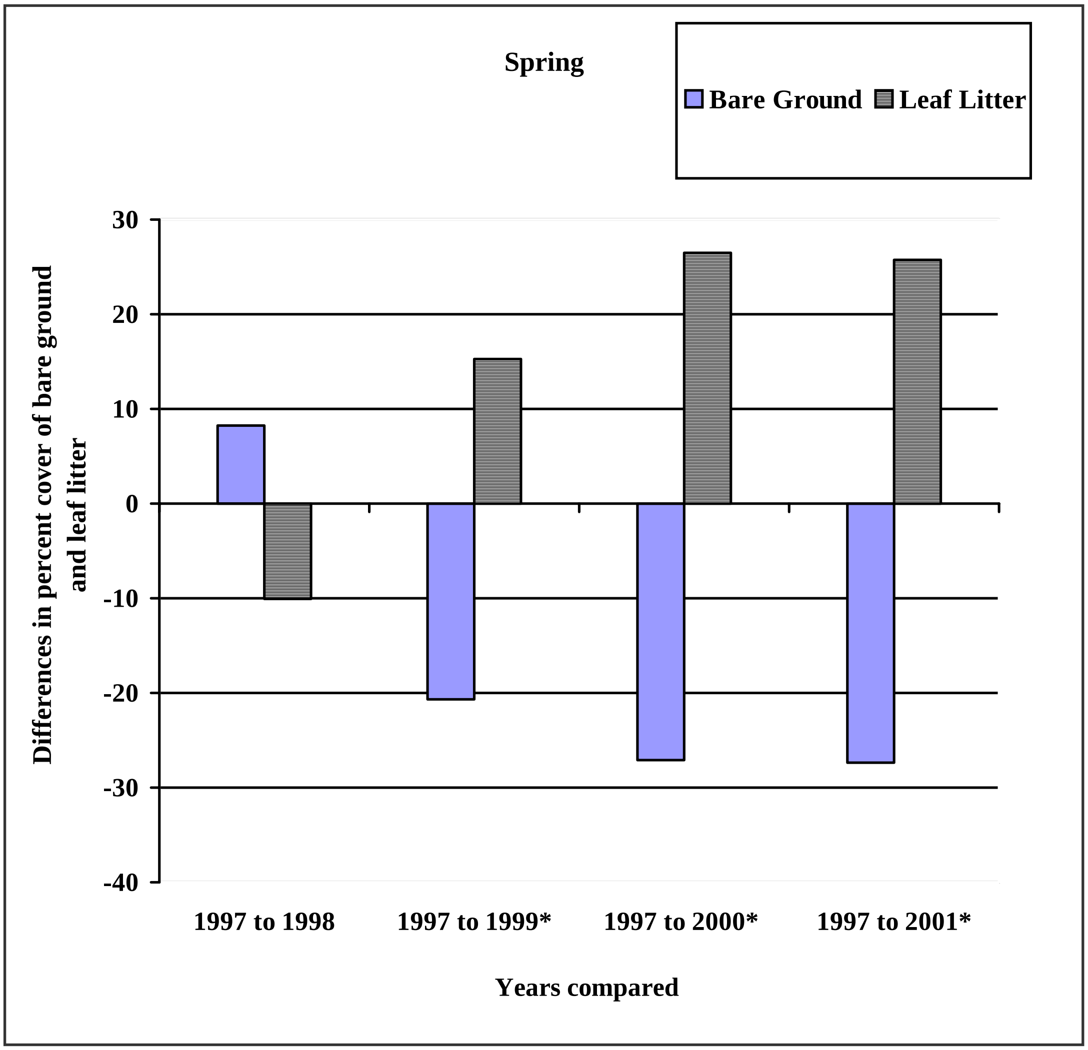


Figure 10. Differences in average percent cover of the bare ground and leaf litter between Spring 1997 and Spring 1998-2001. Cover was bare soil or rock for bare ground and fallen leaves or branches for litter. Averages were taken across 37 quadrants. Asterisks indicated significant differences in the amounts of bare ground and leaf litter when compared to 1997 levels. (From California Department of Parks and Recreation 2002).

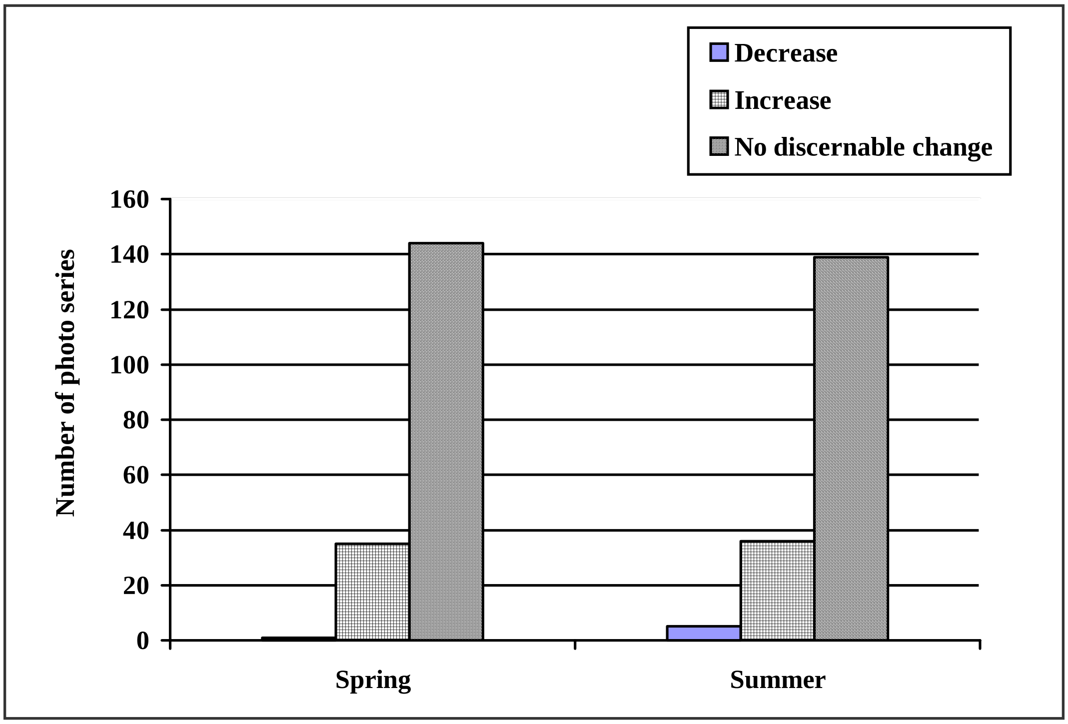


Figure 11. Number of photo series demonstrating an increase, decrease, or no discernable change in tree or shrub cover (n = 180). A photo series consists of photos taken in the same direction from the same location over the sample period (1997-2001). A change in a photo series was recorded where an increase or decrease in shrub or tree cover was demonstrated through the 2001 sampling period. No discernable change was recorded for series that either exhibited no change or where there was no observable reference point. (From California Department of Parks and Recreation 2002).

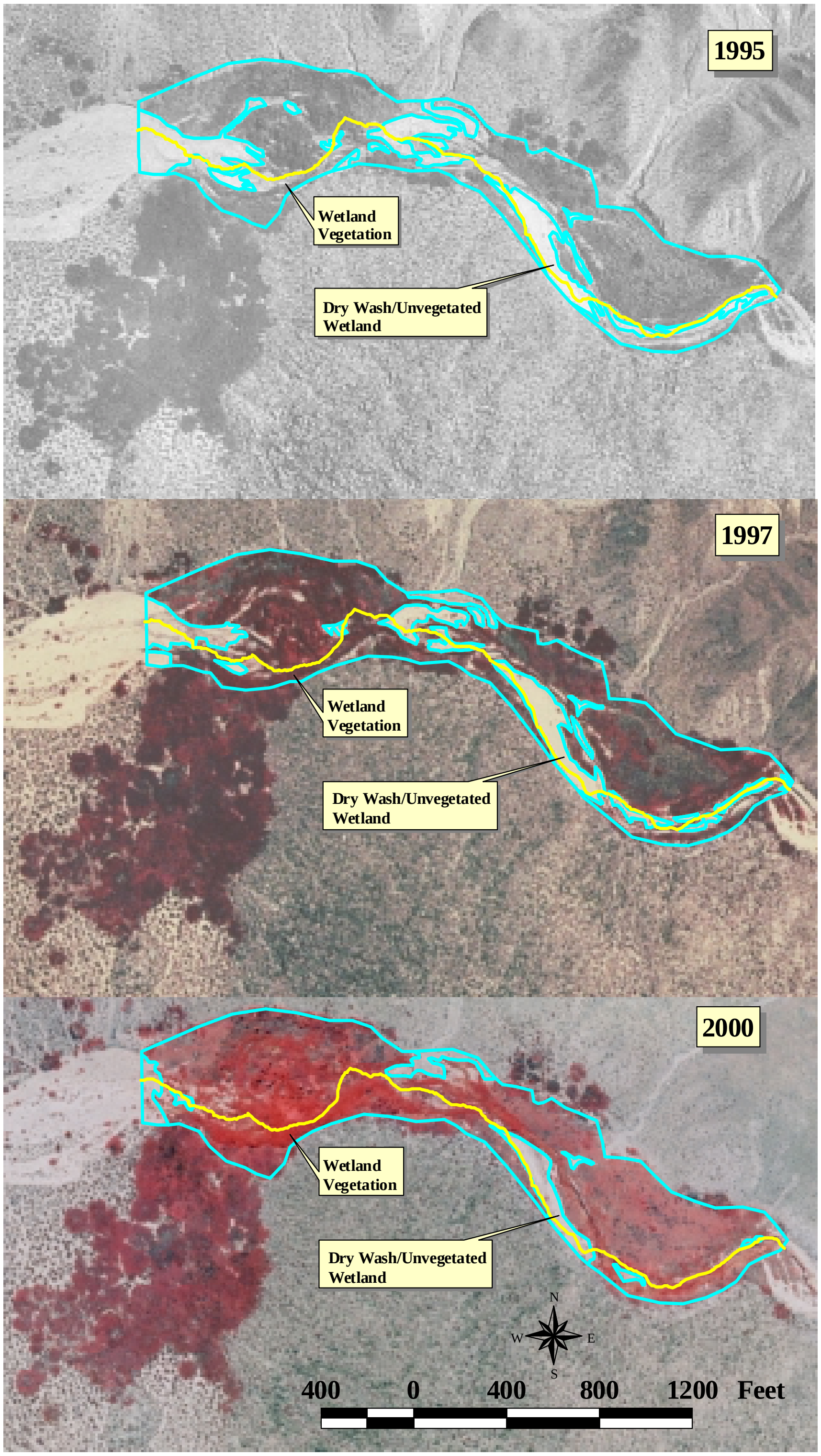


Figure 12. Changes in wetland vegetation coverage in 1995, 1997, and 2000. The yellow line represents the former road (where discernable). Red coloring indicates vegetation. (From California Department of Parks and Recreation 2002).

Conclusion

Results from five years of monitoring (California Department of Parks and Recreation 2002) indicate that vegetation in Coyote Canyon responded positively to management actions implemented in 1996. Although monitoring was only conducted for a relatively short time period, there was strong evidence that improved resource protection enhanced the health of riparian vegetation. While some increases in vegetation structure and cover likely represented post-1993 flood recovery, two lines of evidence suggest increased vegetation is at least in part a consequence of the road closure. First, vegetation height and cover increased in the areas most affected by the road closure (within the former road), while few significant differences were observed floodplain-wide. Secondly, increased vegetation within the former road appeared to be associated with recruitment of shrub species in 1996 or 1997, immediately following the road closure. The shrub species common in this area (mulefat, arrow weed, narrow-leaved willow) typically approach maturity within 3-4 years, corresponding with the significant increases in height and cover that occurred by 2000 and 2001.

The reestablishment of dense and mature riparian vegetation and the lack of channel incision prior to the next major flooding event are key to the recovery of this system. Well-established vegetation and an undisturbed streambed channel will help maximize the lateral migration and diversifying effects of surface flow in Coyote Creek (Matthews 1995). In other words, the vegetation that withstands a flood or becomes established in a channel after a flood serves to direct the flow of water in the next flood to an alternate path. This dynamic cycle of flood scouring and revegetation creates a riparian area composed of patches of plants of various ages and size. The overall effect is to increase the diversity as well as the quality and quantity of habitat for plants and animals.

Removal of motorized vehicle traffic and exotic plant species such as tamarisk allows for the natural succession of desert riparian areas (D'Antonio and Dudley 1997). Succession in Coyote Canyon appears to start with narrow-leaf willow in association with seepwillow, followed by arroyo willow and red willow, and finally white alder and cottonwood. The latter species provide a diverse array of microhabitats for shrubs, forbs, insects, birds and other wildlife (D'Antonio and Dudley 1997). Structural changes in the riparian vegetation that occurred since 1996 are consistent with improved nesting habitat for the state and federally listed endangered least Bell's vireo and southwestern willow flycatcher.

Protecting the integrity of natural processes (succession) and disturbance regimes (floods) in Coyote Canyon is critical for the recovery of canyon's riparian habitat and for maintaining biodiversity. Management changes resulting from implementation of the Public Use Plan have increased resource protection of sensitive riparian areas that will facilitate recovery of the streambed's natural physical characteristics, riparian vegetation, and ultimately habitat for a variety of plants and animals.

AMPHIBIANS

Introduction

Historic records exist for four species of amphibians in Coyote Canyon (Warburton and Fisher 2001): the California treefrog (*Pseudacris cadaverina*), Pacific treefrog (*Pseudacris regilla*), western toad (*Bufo boreas*), and the red-spotted toad (*Bufo punctatus*). All four species are widespread in California. This section of the report examines the relative distribution of amphibians before and after implementation of the Coyote Canyon Public Use Plan.

Standardized field sampling techniques and effort across regions and over time are crucial for accurate amphibian surveys (Gibbons et al. 1997). Amphibian activity periods are strongly influenced by air and water temperature (Bridges and Dorcas 2000, Sargent 2000), as well as species-specific habits. Amphibian surveying is further complicated because amphibians are active for limited periods of time during any day or season, which makes understanding amphibian activity patterns and ecology essential to successful monitoring (Peterson and Dorcas 1992, Heyer et al. 1994). The following is a brief natural history for each of the four species monitored in Coyote Canyon.

California treefrogs range in size from 2.5 – 5.0 centimeters (1.0 – 2.0 inches) and their dorsal color is typically gray or brown with dark blotches. Commonly found in desert arroyos, the California treefrog is distributed discontinuously from San Luis Obispo County to Bahia de Los Angeles, Mexico. This species is found near streams and washes having rocks, quiet pools, and shade. Chiefly nocturnal, but also diurnal, the California treefrog often spends days beneath rocks or within rock crevices. Males call to attract females during the breeding season, which extends from February to October (www.sdnhm.org/fieldguide/herps/hyla-cad.html).

Pacific treefrogs range in size from 2.0 – 2.5 centimeters (0.75 – 1.0 inches) in length and are highly variable in color. Their habitat extends from British Columbia, Canada to the tip of Baja California, Mexico and eastward to Montana and Nevada. They are California's most common amphibian and are found in a wide variety of habitats from sea level to mountaintops, and grasslands to residential areas. These frogs are chiefly nocturnal, with activities concentrated between late afternoon and midnight. They often spend daylight hours beneath logs, rocks, or other debris. During breeding season (November to July), males call to attract females. Reproduction occurs for a few weeks and females deposit eggs in numerous small clusters, usually about 25 eggs per cluster. Individual females may deposit 700 eggs and metamorphosis (development from egg to larvae to adult) can take five weeks (www.sdnhm.org/field-guide/herps/hyla-reg.html).

The red-spotted toad, measuring approximately 8 centimeters (3.0 inches) in length, varies in color from whitish when found in association with limestone, to red when found near volcanic rock. This toad is widely distributed from southern Nevada to southwestern Kansas, south to Hidalgo, Mexico, and throughout Baja California. It occurs at elevations from below sea level to 7,000 feet (1,989 meters). Red-spotted toads are commonly found in rock crevices, near rocky streams and arroyos. This species is nocturnal during the hot summer months but may be diurnal (active in the morning or evening) during the breeding season (Stebbins 1972). Breeding occurs in March to September, mainly after summer rains in quiet pools. The red-spotted toad is the only toad in this region that lays its eggs singly in short strings.

The western toad measures approximately 6.0 – 12.0 centimeters (2.5 – 5.0 inches) in length. It is widely distributed in California, occurring at elevations from sea level to 3050 meters (10,000 feet). They are nocturnal and diurnal, and become inactive when the weather is especially hot, dry, or cold (www.dfg.ca.gov/whdab/cwhr/A032.html). In California, the breeding season extends from January to July depending on local conditions. Females lay over 16,000 eggs in large stringy masses in shallow water (Stebbins 1972).

Approach

Presence/absence data (Knapp 1994, Warburton and Fisher 2001, 2002) were used to evaluate the distribution of the four common amphibian species in Coyote Canyon before and after implementation of the Public Use Plan. Knapp (1994) conducted one-person visual and aural searches of suitable habitats for eggs, tadpoles, juveniles, and adults during the winter (January 31-February 6) and spring (April 17-21) of 1994. Both day and night searches were conducted. Warburton and Fisher (2001, 2002) used two-person survey teams to search streambeds, open pools, and flowing stretches and recorded amphibian larvae, adults, and audible calls that were identifiable to species. Surveys were conducted from May through August 2000 – 2001, typically between noon and dusk. Some habitats were also surveyed at night.

In 1997 and 1998, Jorgensen (2002*a*) conducted amphibian surveys along a 0.4 mile transect along the creek at Middle Willows. Surveys involved walking the length of the transect searching for and counting adults, tadpoles, and calling adults. This data was used to complement the studies of Knapp (1994) and Warburton and Fisher (2001, 2002).

Results and Discussion

Three species (red-spotted toads, California treefrogs, Pacific treefrogs) were found in surveys conducted at Upper, Middle, and Lower Willows before and after the Coyote Canyon Public Use Plan was implemented in 1996 (Table 3). Although western toads were detected at Lower Willows before and after 1996, they were found with less regularity at Middle and Upper Willows. At Middle Willows, western toads were not detected in 1994, 2000, or 2001, but they were found in surveys conducted in 1997 and 1998. At Upper Willows, western toads were identified in 1994, but they were not detected in 2000 or 2001.

Upper, Middle, and Lower Willows provided suitable habitat for all four amphibian species monitored. Lower Willows provided the largest amount of suitable habitat and has been protected from motorized vehicle traffic for the longest period of time (since the bypass road opened in 1988). All four species were detected in Lower Willows before and after 1996 suggesting that habitat quantity and quality, coupled with long-term resource protection, resulted in a healthy environment for amphibians.

Conclusions

Based on scientific literature (Trombulak and Frissell 2000 and references therein), implementation of the Coyote Canyon Public Use Plan provided improved resource protection for amphibians, which is likely to improve amphibian population health. Results of monitoring conducted between 1996-2001 indicated that no large or widespread changes in amphibian diversity or abundance occurred in recent years. It is not clear whether there have been meaningful changes in the occurrence of western toads at Upper or Middle Willows. Continued systematic monitoring (as called for in the State Park's Inventory and Monitoring Assessment Plan) will help clarify the status of amphibian population health in Coyote Canyon.

Table 3. Species of amphibians observed or heard during surveys at Lower, Middle and Upper Willows in Coyote Canyon before (Spring 1994) and after (Spring 2000 and 2001, combined) implementation of the Coyote Canyon Public Use Plan (Knapp 1994, Warburton and Fisher 2001, Jorgensen 2002a).

		Spring 1994		Spring 2000/2001	
Location	**Species**	**Present**	**Absent**	**Present**	**Absent**
Lower Willows	Pacific treefrog	X		X	
	California treefrog	X		X	
	Red-spotted toad	X		X	
	Western toad	X		X	
Middle Willows	Pacific treefrog	X		X	
	California treefrog	X		X	
	Red-spotted toad	X		X	
	Western toad		X		X*
UpperWillows	Pacific treefrog	X		X	
	California treefrog	X		X	
	Red-spotted toad	X		X	
	Western toad	X			X

*Western toads were detected at Middle Willows in 1997 and 1998 (Jorgensen 2002*a*).

LEAST BELL'S VIREO AND SOUTHWESTERN WILLOW FLYCATCHER

Introduction

Coyote Canyon provides habitat for two state and federally listed endangered birds: the south-western willow flycatcher (*Empidonax traillii extimus*) and the least Bell's vireo (*Vireo bellii pusillus*). Threats to both species include extensive loss of riparian habitat, replacement of native riparian vegetation with tamarisk, and nest parasitism by the brown-headed cowbird (*Molothrus alter*) (USFWS 1995, USFWS 1998).

Historically, least Bell's vireo were widespread and abundant. They were considered a common breeding resident in lowland riparian areas throughout California from the northern Sacramento River Valley south into northwestern Baja California, Mexico (Franzreb 1989). Least Bell's vireo experienced dramatic population declines attributed to the loss of over 90 percent of California's riparian habitat and nest parasitism by cowbirds. First listed as an endangered species by the state of California in 1980, the species was federally listed as endangered in 1986. At that time the statewide population was estimated at 300 territorial males. Intensive management efforts, including habitat restoration and cowbird control, increased the least Bell's vireo population to approximately 1,800 males in 1999 (L. Hayes, as cited in Wells and Kus 2001).

Least Bell's vireo are small songbirds that winter in southern Baja California and migrate north to breed in riparian habitats in southern California, including ABDSP. Males are vocal throughout the breeding season and are readily identified by their distinctive song. Females are indistinguishable from males in plumage, but do not sing and are more secretive than males. Primarily insectivorous, least Bell's vireo consume a wide variety of prey species, including caterpillars, beetles, bugs, and moths (USFWS 1998).

Least Bell's vireo begin to arrive on breeding grounds in California from mid-March to May, with the majority of birds arriving in late April. Upon arrival, males establish and begin to defend territories ranging in size from 0.2 to 3.0 hectares (0.5 to 7.5 acres), with an average size of less than one hectare (USFWS 1998). They are obligate riparian breeders who prefer willow-dominated woodland or scrub that typically exists along streams and rivers. Habitat characteristics important for vireo occupation include dense cover one to two meters (3-6 feet) in height above the ground for nesting and foraging, and a dense, stratified canopy providing both foraging habitat and song perches for territorial advertisement. Habitat structure (vegetation density and height) generally appears to be more important for nesting and foraging than plant species composition (USFWS 1998). Lower Willows is federally designated as critical habitat for least Bell's vireo (USFWS 1994). Critical habitat is defined as a specific area occupied by a species that contains physical or biological features essential to the conservation of the species and that may require special management considerations or protection.

The federal recovery plan lists a recovery goal for least Bell's vireo in ABDSP as the establishment of a population or metapopulation (a group of subpopulations) numbering several hundred birds (USFWS 1998). Subpopulations are found in at least 10 drainages within ABDSP, and in recent years roughly one-quarter of the ABDSP vireo population was found in Coyote Canyon (Wells and Kus 2001).

The southwestern willow flycatcher is a neotropical migratory bird, present in its North American breeding habitat (including Arizona and parts of California, Nevada, Utah, Colorado, and New Mexico) from approximately late April through August or September (Unitt 1987). In winter, it migrates to Mexico, Central America, or possibly northern South America (USFWS 1997). The southwestern willow flycatcher was listed as an endangered species in 1995 when the population was estimated to number approximately 300-500 pairs (USFWS 1995).

Southwestern willow flycatchers occur in riparian areas dominated by dense stands of willows (*Salix* spp.), mulefat, arrow weed, and button bush (*Cephalanthus occidentalis*). They typically nest in thickets of trees and shrubs approximately 4-7 meters (13-23 feet) or more in height that provide dense foliage at 0-4 m (13 feet) above ground (USFWS 1995). Critical habitat was designated in July 1997 (USFWS 1997); however, a recovery plan for this species currently does not exist.

Although Coyote Canyon is recognized as habitat for southwestern willow flycatchers, there have been no confirmed sightings of these birds in the canyon. A number of factors make surveying and identifying willow flycatchers difficult (Sogge et al. 1997). Ten different flycatchers in the genus *Empidonax* are common in North America, and all are nondescript and similar in appearance. Southwestern willow flycatchers have a distinct song, but they are not vocal at all times of the day or during all parts of the breeding season. Furthermore, their preference for dense habitat makes them difficult to locate.

The migrant willow flycatcher (*E.t. brewsteri*) is widespread throughout southern California, (including ABDSP; Unitt 1987) and is indistinguishable in the field from the southwestern willow flycatcher (*E.t. extimus*). The only practical method for documenting southwestern willow flycatchers is to document nesting within the park. Thus far, nesting by southwestern willow flycatchers in Coyote Canyon has not been documented. All current records of willow flycatchers in Coyote Canyon are most likely sightings of *E. t. brewsteri*. Wells and Kus (2001) observed five willow flycatchers at Lower Willows in June 2000, but they were unable to determine the subspecies of these flycatchers.

Because nesting by southwestern willow flycatchers in Coyote Canyon has not been confirmed, no attempt could be made to assess changes in the status of these birds resulting from implementation of the Public Use Plan. However, the status of least Bell's vireo before and after implementation of the Public Use Plan was evaluated by examining the distribution and abundance of territorial males in Coyote Canyon.

Approach

The status of least Bell's vireo at 8 locations within Coyote Canyon was assessed using survey data collected from 1990 through 2001 (Jones 1990; Pluff 1991, 1992, 1993, Jorgensen 1994, 1995, 1996, 2002*b*; Jorgensen and Jorgensen 1997, 1998, 2000, Wells and Kus 2001; Unit *in prep*). Middle and Upper Willows were regularly included in surveys beginning in 1993. Surveys (typically one-day visits) were conducted during April or May (the breeding season) by experienced personnel who counted the number of singing males present in each area. Survey personnel walked along or through suitable vireo habitat listening and watching for vireo. During 2000, Wells and Kus (2001) spent 34 days in ABDSP performing vireo surveys and monitoring nesting success at 14 sites including Lower, Middle, and Upper Willows.

To identify changes in the abundance of territorial male vireo, a linear regression analysis was conducted to test the null hypothesis that there was no change in the number of territorial males counted from 1990 (or 1993) through 2001 at each of the three willow areas. For statistical analyses, SPSS 8.0 software was used and the statistical significance (alpha) was set at $P < 0.05$.

Results and Discussion

Least Bell's vireo were found in Coyote Canyon every year from 1990 through 2001 (Table 4). Vireo were found in Lower Willows every year it was surveyed, as well as in Middle Willows after 1992. The occurrence of vireo in Upper Willows, Sheep, Salvador, and Horse canyons was sporadic (Table 4). Cougar Canyon was surveyed only three times (1993, 1994, and 1997) and no vireo were found.

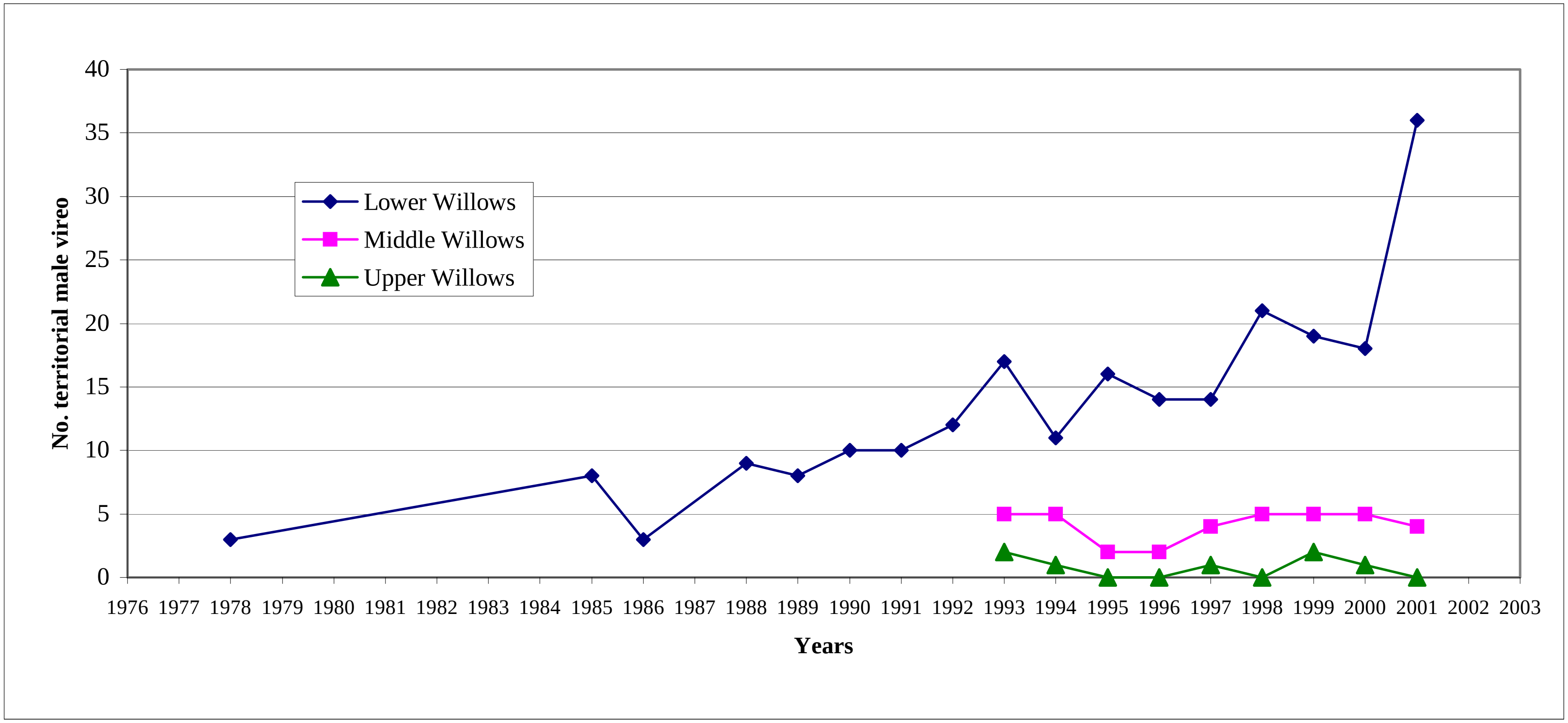
From 1990 through 2001, there was a significant increase in the number of males at Lower Willows, with approximately twice as many males ($n = 36$) present in 2001 as in previous years (Figure 13, Table 4). Cowbird removal efforts (Table 1) initiated in 1986 near Lower Willows likely played an important role in increasing the population size at this location. Other factors that

Table 4. Number of territorial male least Bell's vireo and number of site visits (in parentheses) per survey area in Coyote Canyon (Jones 1990; Pluff 1991, 1992, 1993; Jorgensen 1994, 1995, 1996, 2002b; Jorgensen and Jorgensen 1997, 1998, 2000; Wells and Kus 2001; Unit in prep).

Year	Cougar Canyon *n* (visits)	Horse Canyon *n* (visits)	Indian Canyon *n* (visits)	Lower Willows *n* (visits)	Middle Willows *n* (visits)	Salvador Canyon *n* (visits)	Sheep Canyon *n* (visits)	Upper Willows *n* (visits)	Total
1990	Ns	Ns	Ns	10 (*)	Ns	Ns	Ns	Ns	10
1991	Ns	Ns	Ns	13 (*)	0 (3)	Ns	Ns	Ns	13
1992	Ns	Ns	Ns	17 (1)	Ns	Ns	Ns	Ns	17
1993	0 (1)	Ns	0 (1)	11 (3)[1]	5 (4)[1]	0 (1)	0 (1)	2 (3)[1]	18
1994	0 (1)	1 (2)	2 (1)	16 (5)	5 (6)	Ns	1 (1)	1 (1)	26
1995	Ns	1 (1)	Ns	12 (4)	2 (5)	Ns	0 (1)	0 (3)	15
1996	Ns	0 (2)	Ns	16 (2)	2 (1)	1 (1)	1 (1)	0 (2)	20
1997	0 (1)	0 (1)	Ns	14 (2)	4 (3)	0 (2)	0 (1)	1 (1)	19
1998	Ns	1 (1)	Ns	21 (2)	5 (2)	0 (1)	Ns	0 (2)	27
1999	Ns	Ns	Ns	19 (1)	5 (1)	Ns	1 (2)	2 (1)	27
2000	Ns	Ns	Ns	18 (7)	5 (3)	Ns	Ns	1 (2)	24
2001	Ns	0 (1)	Ns	36 (1)	4 (1)	Ns	1 (1)	0 (1)	41
Total	**0**	**3**	**2**	**203**	**37**	**1**	**4**	**7**	**257**

n = number of territorial male vireo
Ns = not surveyed
*regularly monitored between April 16 and July 29
[1] Storms in the winter of 1993 altered the available vireo habitat in Coyote Canyon and likely resulted in the shift of vireos from Lower Willows to Middle and Upper Willows. This was the first year LBV were found nesting in Middle and Upper Willows.

Figure 13. Number of territorial male vireos in Lower, Middle, and Upper Willows (1978-2001). Data was compiled from several sources (Jones 1990; Pluff 1991, 1992, 1993; Jorgensen 1994, 1995, 1996, 2002b; Jorgensen and Jorgensen 1997, 1998, 2000; Wells and Kus 2001; Unit in prep).



may have enhanced habitat quality for least Bell's vireo in Lower Willows include removing cattle from the canyon in 1987 (Overmire 1962, Van Cleve et al. 1989), construction of the bypass road in 1988, and removal of tamarisk from riparian habitat (USFWS 1998). Habitat restoration studies (Kus 1998; USFWS 1998) suggest that vegetation may require 5-10 years to develop the structure (height and density) that provides optimal least Bell's vireo nesting and foraging habitat.

Regression analysis indicated no significant trend (increase or decrease) in the number of singing males at Middle or Upper Willows from 1993 through 2001 (Figure 13, Table 4). However, vegetation analyses conducted at Middle and Upper Willows revealed that significant changes in vegetation structure occurred after the road closure (see Vegetation Section). More specifically, the density and height of plants 1-3 meters tall increased, which should favor least Bell's vireo nesting and foraging. Because vegetation may require 5-10 years to fully recover to optimal vireo habitat (Wells and Kus 2001), there may be a lag time before the vireo population responds to improved conditions at Middle and Upper Willows.

Both management actions and natural phenomena may have influenced the distribution and abundance of least Bell's vireo in Coyote Canyon during the monitoring period. For example, the major flood event in January 1993 temporarily reduced vireo habitat at Lower Willows, and may have resulted in more birds searching for suitable habitat at Middle and Upper Willows (Table 4). Removal of tamarisk from throughout the Canyon improved habitat conditions for vireo, (USFWS 1998; Recovery Task 1.7) as did cowbird trapping efforts initiated in 1986.

Cowbird nest parasitism is likely to continue to impact least Bell's vireo, particularly in more remote areas such as Middle and Upper Willows, where trapping and removal may be impractical. Even in Lower Willows, nest parasitism continues to be a problem. In 2000, 2 of 11 (18%) of the monitored nests in Lower Willows were parasitized by cowbirds (Wells and Kus 2001). Continued cowbird trapping is recommended to facilitate recovery of least Bell's vireo and southwestern willow flycatchers.

Conclusions

The status of least Bell's vireo and their habitat in Coyote Canyon has improved since 1990. Lower Willows offers the largest amount of habitat and has received the highest level of use during the breeding season. Least Bell's vireo show a general tendency to return to and nest in the area where they were born (USFWS 1998). Thus, it is likely that each year an increasing number of birds will search for nesting and foraging habitat in Coyote Canyon. As habitat at Lower Willows becomes more densely occupied, vireo may expand their use of Middle and Upper Willows assuming that habitat conditions are suitable. Changes documented through vegetation monitoring since 1996 suggest that returning vireo will find progressively more favorable conditions at Middle and Upper Willows.

Surveys conducted from 1990 through 2001 clearly demonstrated that Lower, Middle and Upper Willows provide important vireo habitat. Recent management actions, including the closure of the road through Middle and Upper Willows, strengthened the level of resource protection provided to these areas and will assist with the ongoing recovery of this species. The recovery and improved protection of riparian vegetation at Middle and Upper Willows are also anticipated to enhance habitat conditions for the southwestern willow flycatcher.

BIGHORN SHEEP

Introduction

Bighorn sheep (*Ovis canadensis*) are native to the Peninsular Mountain Ranges in southern California and inhabit the dry, rocky slopes from the San Jacinto Mountains near Palm Springs south into Baja California, Mexico. Peninsular bighorn within the U.S. are geographically clustered into approximately eight subpopulations that are linked primarily through movement of rams. Six subpopulations are currently recognized within ABDP, including one located in Coyote Canyon (Rubin et al. 1998).

The overall number of bighorn sheep in the Peninsular Ranges declined during the 1970s and 1980s from an estimated 1,170 in 1974 (Weaver 1975) to 280 in 1996 (Rubin et al. 1998). This population decline was attributed to the synergistic effects of disease, loss of habitat, human disturbance, and mountain lion predation (USFWS 2000). Because of threats to their long-term survival, they were state-listed as threatened in 1971, and federally listed as endangered in 1998. As a result of the federal listing, a recovery plan was developed to identify and guide management activities that would promote their immediate and long-term survival (USFWS 2000).

According to the Recovery Plan (USFWS 2000), the benchmark for recovery of bighorn sheep in Coyote Canyon is the presence of at least 25 ewes over a period of 12 years. The number of animals in a bighorn sheep population depends primarily on the success or failure of ewes in producing and raising lambs (reproductive success) and the ability of adult bighorn sheep (especially ewes) to survive over time (survival rates). The status of bighorn sheep in Coyote Canyon before and after 1996 was evaluated to determine if this subpopulation was progressing toward the recovery goal.

Approach

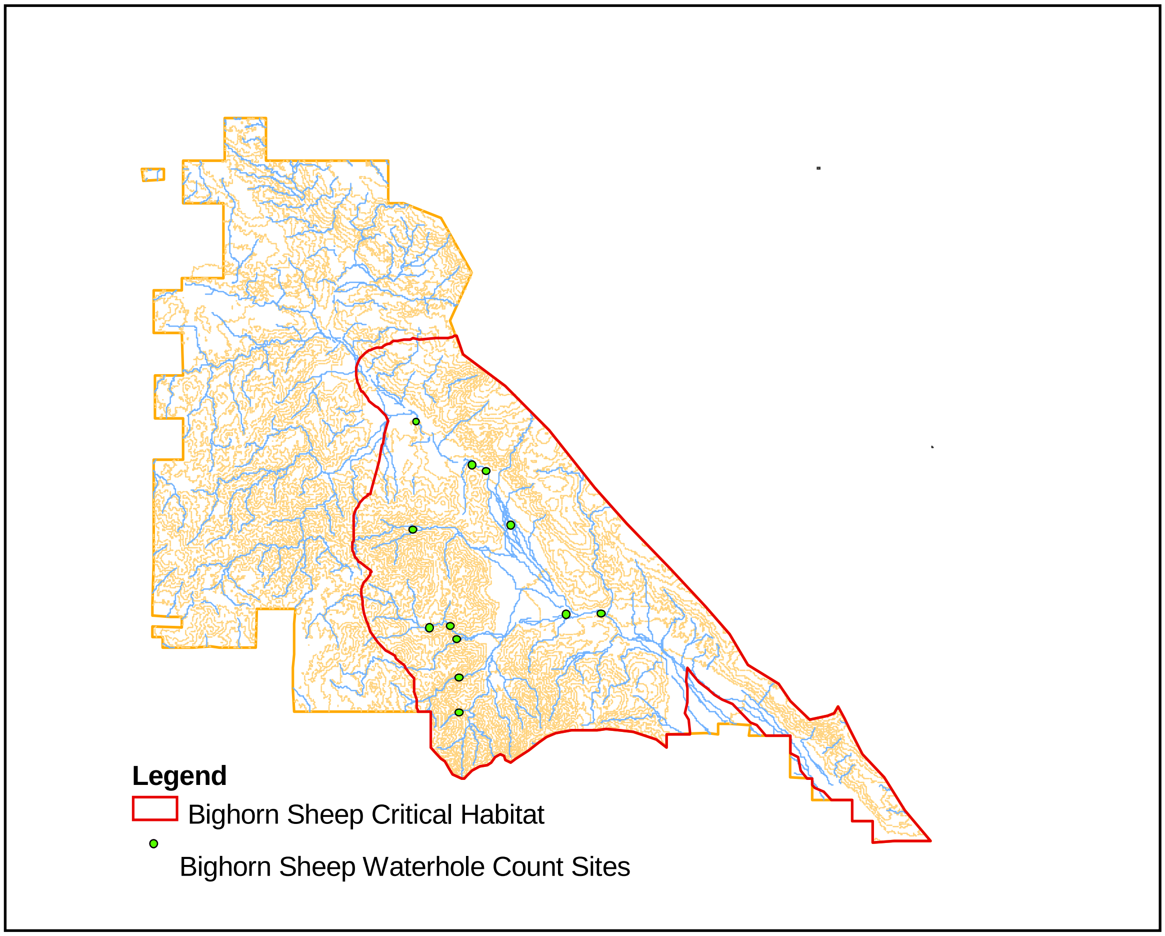
Monitoring data from a variety of sources was used to evaluate the distribution, abundance, reproductive success, and survival of bighorn sheep in Coyote Canyon. Statistical analyses were performed where appropriate to identify changes in these parameters before and after 1996. The software program SPSS 8.0.0 was used for all statistical analyses and alpha (statistical significance) was set at 0.05.

Park personnel and volunteers have conducted annual counts of bighorn sheep at 49 waterhole sites each July or August since 1971. Waterhole count data (ABDSP Annual Waterhole Count Summary Sheets 1985-2001) were used to evaluate changes in bighorn sheep distribution and abundance. Count sites within Coyote Canyon were grouped into 6 count areas: Lower Willows, Cougar Canyon, Salvador Canyon, Monkey Hill, Middle Willows, and Upper Willows (Figure 14). To assess bighorn distribution, we graphed the presence or absence of bighorn sheep at each count area for each year from 1985 through 2001. To identify changes in bighorn sheep abundance, we conducted a linear regression analysis to test the null hypothesis that there was no change in the number of ewes counted from 1985 through 2001 (*sensu* Rubin et al. 1998).

Helicopter surveys of bighorn sheep in the Peninsular Ranges south of the Santa Rosa Mountains have been conducted every other year since 1994 (Rubin et al. 1998). Helicopter survey data were used to evaluate recent bighorn sheep distribution, population estimates, and reproductive success. Over 100 animals have been radiocollared range-wide since 1992, and these radiocollared animals provided a means of calculating the population size based on Chapman's (1951) modification of the Peterson estimator (Seber 1982). We compared population estimates using a method described by Seber (1982:121) for testing the null hypothesis that population size did not change between any two consecutive time periods.

Data from 22 bighorn sheep in Coyote Canyon that were radiocollared between September 1993 and October 2001 were used to assess the distribution and survival rates of bighorn sheep in Coyote Canyon. Between 1994 and 2001, these bighorn sheep were monitored for

Figure 14. Critical habitat (defined by USFWS 2000) and locations of bighorn waterhole count sites within Coyote Canyon.



mortalities at least quarterly (every 3 months) through a combination of ground fieldwork and fixed-wing telemetry flights. Mortality signals from radiocollars were investigated as soon as possible after detection, and in each case a determination was made as to whether or not mountain lion predation was the likely cause of death (Hayes et al. 2000). Quarterly and annual survival rates were calculated using the Kaplan-Meier method modified for a staggered entry design (Pollock et al. 1989). Survival rates were examined for an increase between pre-1996 and post-1995 bighorn sheep using a one-tailed t-test.

Results and Discussion

The distribution of bighorn sheep in Coyote Canyon has been reduced since the 1980s, when bighorn use of the southwestern side of the canyon began to diminish. This trend has continued (Figure 15). Bighorn sheep were seen in the Cougar Canyon area (southwestern Coyote Canyon) every year during waterhole counts from 1985 through 1989, but only twice between 1990-2001. Additionally, the majority of animals located in helicopter surveys and aerial fixed wing flights since 1993 have been located on the northeastern side of Coyote Canyon.

With regard to Upper, Middle, and Lower Willows, no changes were detected in distribution before and after 1996 with the possible exception of bighorn sheep use of Upper Willows. No bighorn sheep have been seen during waterhole counts at this site since 1997, although they have been seen on other occasions in recent years (S. Martin, personal communication). It may be relevant that Upper Willows is heavily used by feral horses. Bighorn sheep and feral horses will be intensively monitored over the next two years to address this issue.

The Coyote Canyon bighorn sheep population has declined substantially relative to earlier indices of abundance available for this area. The number of ewes counted per day during waterhole counts declined significantly at an average rate of 2.6% per year between 1971-1996 (Rubin et al. 1998). However, for the 10 years before and the 6 years after implementation of the Public Use Plan, we found no statistically significant trends in ewe abundance (Figure 16). These results are partially corroborated by helicopter surveys that showed no significant increase or decrease in population size between 1994 and 2000 (Table 5). These findings indicate that by 1985 the downward trend in bighorn population size in Coyote Canyon had subsided.

Table 5. Adult bighorn (including yearlings) population estimates and 95% confidence intervals for Coyote Canyon based on helicopter surveys (Rubin et al. 1998;Rubin and Botta 2000).

	Males and females	Female only
Year	**Number of bighorn (95% CI)**	**Number of bighorn (95% CI)**
1994	29.3 (21.9-36.8)	21.8 (15.4-28.2)
1996	37.0 (08.2-65.8)	23.0 (05.5-40.5)
1998	35.3 (26.2-44.3)	22.8 (17.5-28.0)
2000	35.0 (21.7-48.3)	23.0 (14.9-31.1)

Figure 15. Presence or absence of bighorn sheep in Coyote Canyon during annual waterhole counts from 1985-2001.

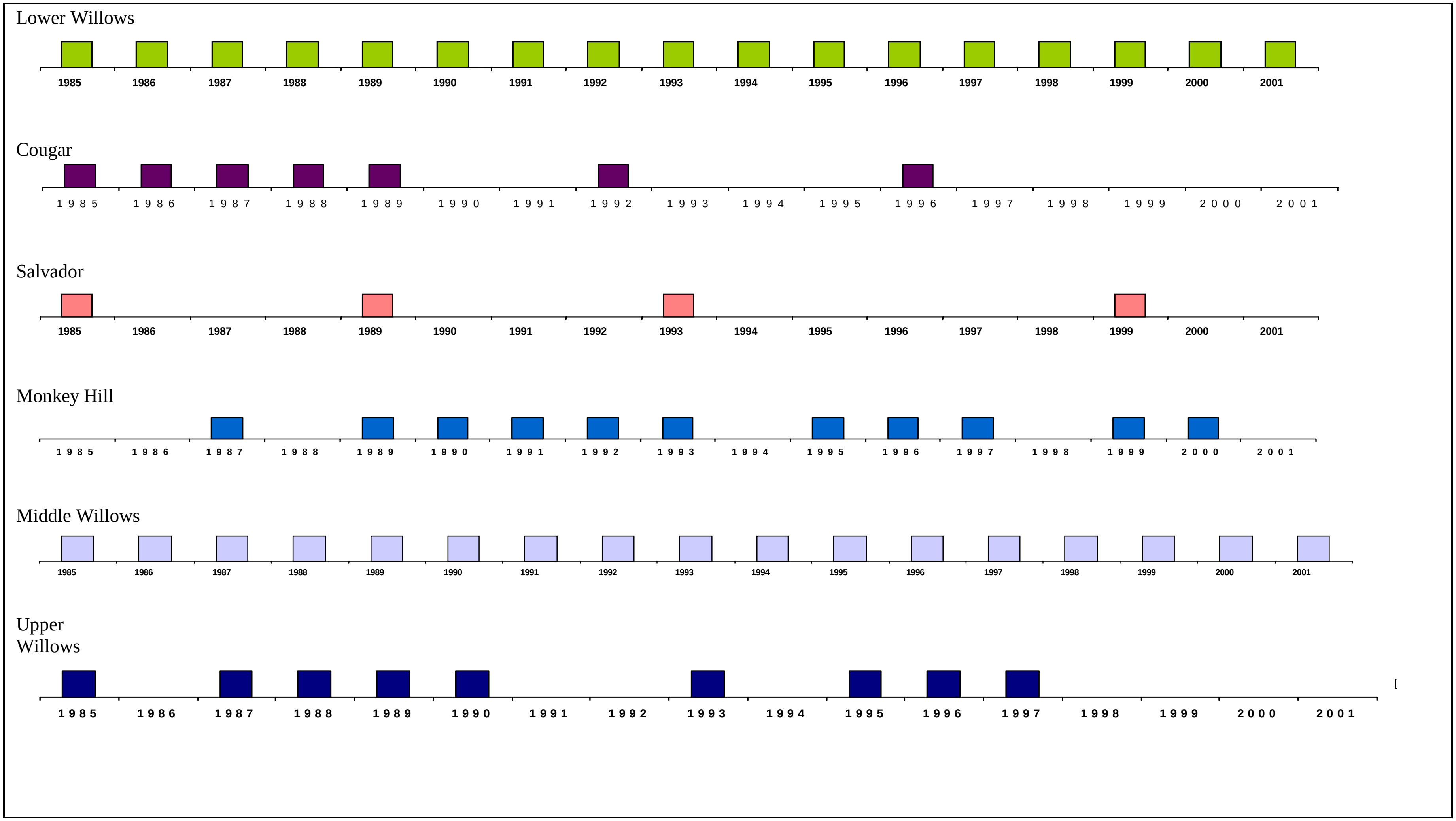


Figure 16. Number of ewes per day at annual waterhole count sites within Coyote Canyon from 1985-2001.

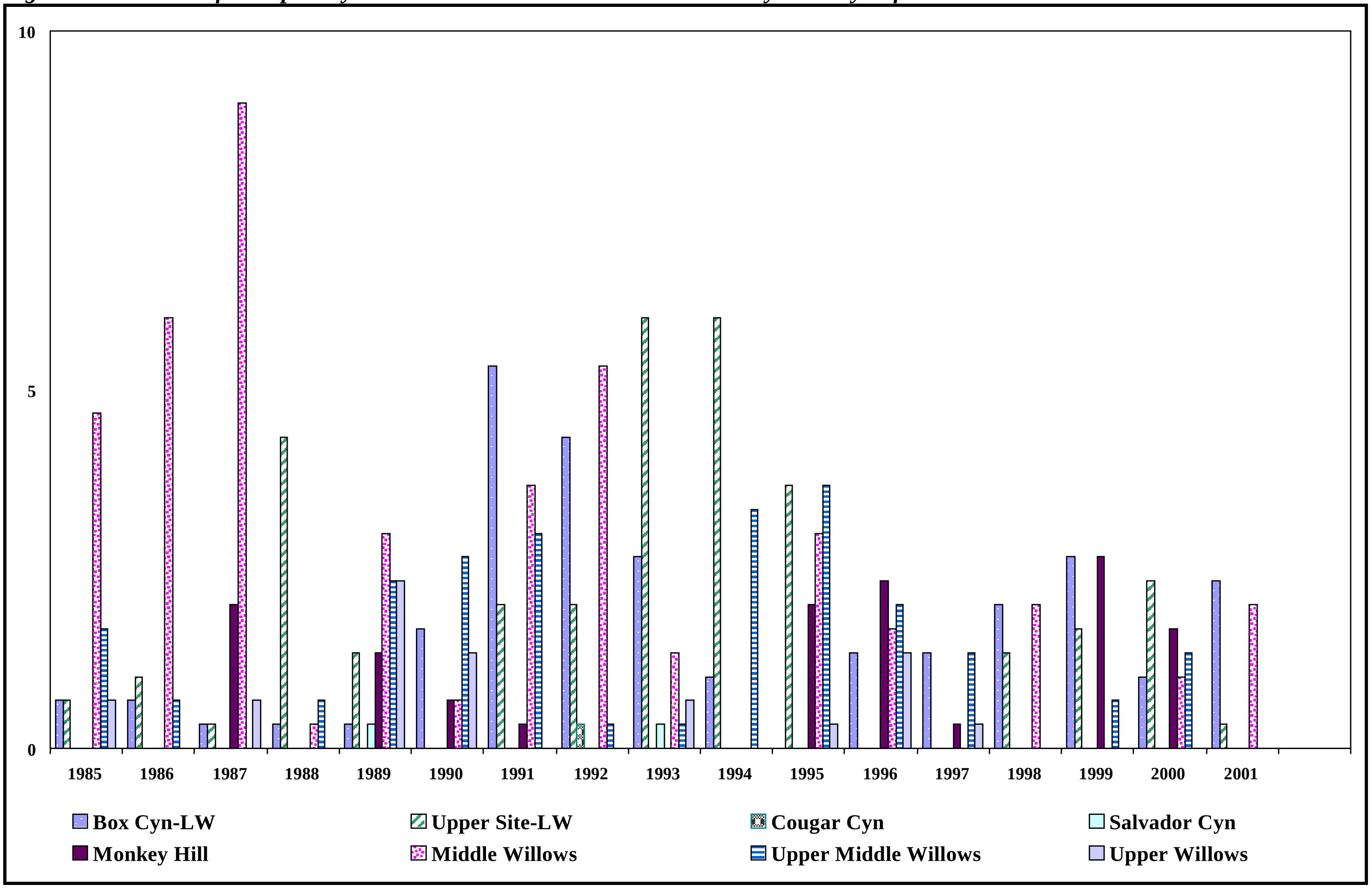


Figure 17. Lamb to ewe ratios for bighorn sheep in Coyote Canyon from 1985-2001. Waterhole count data was collected during July or August, and helicopter surveys were conducted in October.

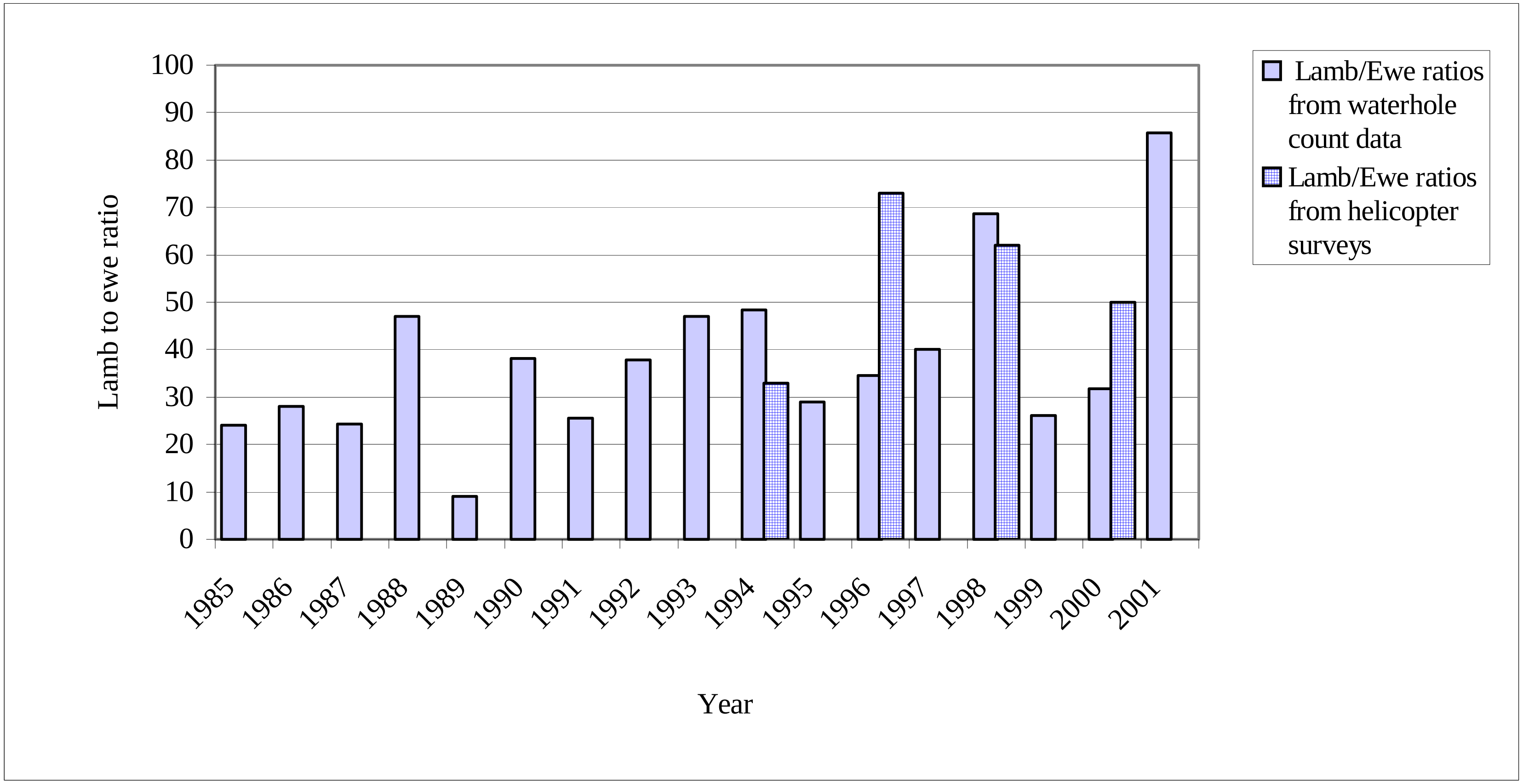


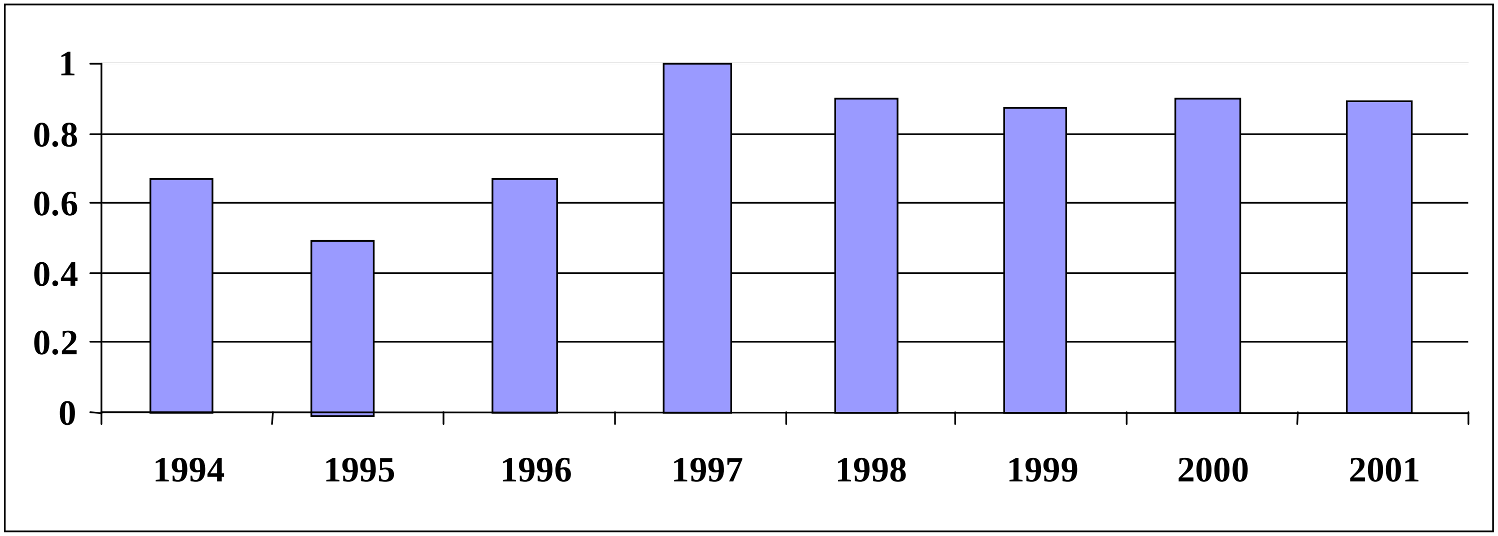
Table 6. Quarterly and annual survival rates for radio-collared bighorn sheep in Coyote Canyon 1994-2001. Survival rates were calculated using the Kaplan-Meier method modified for a staggered entry design (Pollock et al. 1989). Animals were censored if their radiocollar failed or they left the study area.

Time period	No. of collared animals	No. of deaths	No. of animals censored	No. of newly collared animals	Survival rate	Lower CI	Upper CI	Variance of survival rate
Jan-Mar 1994	9	0	0	0	1.0000	1.0000	1.0000	0.0000
Apr-Jun 1994	9	1	0	0	0.8889	0.6953	1.0825	0.0098
Jul-Sep 1994	8	1	0	0	0.7778	0.5237	1.0319	0.0168
Oct-Dec 1994	7	1	0	0	0.6667	0.3815	0.9518	0.0212
1994	-	-	-	-	0.6667	0.3815	0.9518	0.0212
Jan-Mar 1995	6	2	0	0	0.6667	0.3587	0.9747	0.0247
Apr-Jun 1995	4	0	0	0	0.6667	0.2895	1.0439	0.0370
Jul-Sep 1995	4	0	0	0	0.6667	0.2895	1.0439	0.0370
Oct-Dec 1995	4	1	0	0	0.5000	0.1535	0.8465	0.0313
1995	-	-	-	-	0.5000	0.1535	0.8465	0.0313
Jan-Mar 1996	3	0	0	0	1.0000	1.0000	1.0000	0.0000
Apr-Jun 1996	3	0	0	0	1.0000	1.0000	1.0000	0.0000
Jul-Sep 1996	3	0	0	0	1.0000	1.0000	1.0000	0.0000
Oct-Dec 1996	3	1	0	0	0.6667	0.2311	1.1022	0.0494
1996	-	-	-	-	0.6667	0.2311	1.1022	0.0494
Jan-Mar 1997	2	0	0	0	1.0000	1.0000	1.0000	0.0000
Apr-Jun 1997	2	0	0	0	1.0000	1.0000	1.0000	0.0000
Jul-Sep 1997	2	0	0	0	1.0000	1.0000	1.0000	0.0000
Oct-Dec 1997	2	0	0	8	1.0000	1.0000	1.0000	0.0000
1997	-	-	-	-	1.0000	1.0000	1.0000	0.0000
Jan-Mar 1998	10	1	0	0	0.9000	0.7236	1.0764	0.0081
Apr-Jun 1998	9	0	0	0	0.9000	0.7141	1.0859	0.0090
Jul-Sep 1998	9	0	0	0	0.9000	0.7141	1.0859	0.0090
Oct-Dec 1998	9	0	1	0	0.9000	0.7141	1.0859	0.0090
1998	-	-	-	-	0.9000	0.7141	1.0859	0.0090

Table 6. Continued.

Time period	No. of collared animals	No. of deaths	No. of animals censored	No. of newly collared animals	Survival rate	Lower CI	Upper CI	Variance of survival rate
Jan-Mar 1999	8	1	0	0	0.8750	0.6606	1.0894	0.0120
Apr-Jun 1999	7	0	0	0	0.8750	0.6458	1.1042	0.0137
Jul-Sep 1999	7	0	0	0	0.8750	0.6458	1.1042	0.0137
Oct-Dec 1999	7	0	0	3	0.8750	0.6458	1.1042	0.0137
1999	-	-	-	-	0.8750	0.6458	1.1042	0.0137
Jan-Mar 2000	10	0	0	0	1.0000	1.0000	1.0000	0.0000
Apr-Jun 2000	10	0	0	0	1.0000	1.0000	1.0000	0.0000
Jul-Sep 2000	10	1	0	0	0.9000	0.7236	1.0764	0.0081
Oct-Dec 2000	9	0	0	0	0.9000	0.7141	1.0859	0.0090
2000	-	-	-	-	0.9000	0.7141	1.0859	0.0090
Jan-Mar 2001	9	1	0	0	0.8889	0.6953	1.0825	0.0098
Apr-Jun 2001	8	0	0	0	0.8889	0.6836	1.0942	0.0110
Jul-Sep 2001	8	0	0	0	0.8889	0.6836	1.0942	0.0110
Oct-Dec 2001	8	0	0	5	0.8889	0.6836	1.0942	0.0110
2001	-	-	-	-	0.8889	0.6836	1.0942	0.0110

Figure 18. Annual survival rates of radiocollared bighorn sheep in Coyote Canyon, 1994-2001.



The number of lambs and ewes seen during helicopter surveys (Figure 17) provides a means for assessing reproductive success. Lamb to ewe ratios during the monitoring period (1996, 1998, 2000) averaged 61.7 (SD = 11.5). Compared to values for other desert bighorn sheep populations (Hass 1993, DeForge et al. 1995, Rubin et al. 2000, Ostermann et al. 2001), Coyote Canyon bighorn sheep have had high reproductive success in recent years. High reproductive success reflects favorable conditions for bighorn sheep within Coyote canyon. The Coyote Canyon bighorn population is poised to increase if adult mortality rates remain low.

Of the 22 bighorn sheep collared in Coyote Canyon between September 1993 and October 2001, 12 died and one was censored (removed from the analysis) due to radiocollar failure. Ten mortalities were attributed to mountain lion predation and two to possible mountain lion predation. Mountain lion predation was also the most common cause of death for bighorn sheep throughout the Peninsular Ranges during 1992-1998 (DeForge et al. 1997, Hayes et al. 2000).

From 1994-1996, annual survival rates for adult bighorn sheep in Coyote Canyon ranged from 0.50 to 0.67 (Table 6). In other words, adult bighorn sheep had between a 50-67% chance of surviving until the end of the year in 1994, 1995, and 1996. Beginning in 1997, survival rates increased and they remained high through 2001 (Figure 18). The average survival rate from 1996-2001 (average = 0.87, variance = 0.01) was significantly higher (t = -3.04, P = 0.05) than from 1994-1995 (average = 0.58, variance = 0.01)

The 50% increase in survival rates between time periods is a significant step towards population recovery. Rubin et al. (*in press*) developed a demographic model for bighorn sheep and examined the relative importance of vital rates (reproductive success, adult survival, etc.) on the risk of extinction. This model demonstrated that survival of adult female bighorn sheep was the most important factor influencing population viability and persistence. For example, model results suggested that a 20% increase in survival rates for female bighorn sheep in Coyote Canyon would decrease the risk of extinction by 50%.

Conclusions

The overall status or health of the bighorn sheep subpopulation in Coyote Canyon has improved from that seen prior to 1996. The positive turn of events in Coyote Canyon in the 1990's occurred concurrently with implementation of Public Use Plan. Reproductive success and survival rates ultimately determine population abundance, and there is convincing evidence that survival rates for adult bighorn sheep have increased. Furthermore, since 1996 at least 50% of the lambs born each year have survived to at least 6 months of age. Increased survival and reproductive success are strong indicators of progress toward increased population size. Because bighorn sheep are long-lived animals, increases in abundance occur relatively slowly. The maximum rate of increase for a bighorn sheep population approaches 31% per year (Beuchner 1960). Therefore, a population could double in 2.3 years; however, this would require a population having no mortality and an age-sex structure skewed toward adult females (Shackleton et al. 1999).

The Coyote Canyon Public Use Plan improved protection of bighorn sheep and their habitat. The Plan addresses several tasks in the federal recovery plan that apply to Coyote Canyon (USFWS 1998, Table 12), including: (1) Task 1.1.3.1 to remove exotic vegetation such as tamarisk, (2) Task 1.1.3.5. to maintain and re-establish habitat connectivity throughout all habitat, (3) Task 1.2.2.2. to manage activities within bighorn sheep habitat that fragment or interfere with bighorn sheep resource use patterns or other behaviors. An important component of the Plan is the provision for an additional 30 days of protection for bighorn sheep using watering sources at Middle and Upper Willows. A study of vehicle use and bighorn sheep watering habits conducted in Coyote Canyon (Jorgensen 1974) found that bighorn watered substantially less when vehicles were present in the canyon than when they were absent. Results from this study provided the impetus for the summer closure of the canyon instituted in 1975. Management actions in the Public Use Plan are consistent with the goals of the federal recovery plan for bighorn sheep in the Peninsular Ranges (USFWS 2000). Namely, these are to protect essential habitat and to increase the abundance and distribution of sheep such that they are no longer in danger of extinction.

Monitoring programs are now in place to provide information to assess future changes in bighorn sheep distribution, abundance, reproduction, and survival. Approximately 30% of the adult females in Coyote Canyon are radiocollared and monitored for survival. Yearly waterhole counts will continue, as will every other year helicopter surveys for estimating population size. Global Positional System radiocollars were placed on bighorn sheep in 2001 to better monitor their habitat use and movements. In 2002, a study investigating potential interactions between feral horses and bighorn sheep in the Canyon will commence.

QUALITY OF RECREATION

Introduction

Anza-Borrego Desert State Park® offers a wide range of recreational opportunities for park visitors. A primary objective of the Coyote Canyon Public Use Plan was to improve the quality of recreation in the canyon. Because surveys were not conducted prior to Plan implementation, it was not possible to determine whether recreational quality improved. Rather, available data were used to describe current recreational quality in the canyon and the extent of support for park management.

Approach

Relevant data and results from two visitor use surveys conducted since implementation of the Coyote Canyon Public Use Plan provided information regarding recreational quality and the level of support of park management. ABDSP personnel distributed the first survey to Coyote Canyon visitors between January and April 1998 (unpublished data, ABDSP). This survey (Appendix A) addressed how visitors used the canyon and how the Public Use Plan affected their experience in the canyon. The second survey (Freimund and Peel 2001) was conducted by ABDSP personnel and researchers from the University of Montana at six sites within the park, including Coyote Canyon, during the months of November 2000 and March 2001. This survey (Appendix B) asked a wide range of questions to characterize park visitors, the nature of their visit, their motivation for coming to the park, and their perception of how the park is being, or should be, managed.

Results and Discussion

ABDSP personnel offered approximately 400 survey cards to visitors entering Coyote Canyon between January and April 1998, and surveys were returned either to park staff or via U.S. mail to the park. A total of 166 survey cards were completed and used for data analysis. In response to the question of how the recent management changes in Coyote Canyon affected their experience, 57% of respondents favored the changes, 26% made no comment, 13% responded in a negative manner, and 4% made negative comments unrelated to the Public Use Plan. In rating the overall quality of their recreational experience in the canyon, 55% rated it excellent, 39% rated it good, 5% rated it fair, and 1% rated it poor. The high percentage (94%) of visitors reporting a good or excellent recreational experience suggested that visitors were satisfied with the management and the quality of recreation in Coyote Canyon.

Approximately 70% of the surveys distributed to park visitors in the Freimund and Peel (2001) survey were completed, including 344 responses from visitors to Coyote Canyon. The top reason visitors gave for visiting Coyote Canyon was to learn more about nature. Visitors valued the canyon's scenic beauty, unique characteristics, wilderness, and nature displays (Table 7). Visitors also strongly supported management actions that protected resources, wildlife and solitude (Table 8). In contrast, the least supported management action was increasing off-road use, and this was true for visitors surveyed at all six sites in the park.

Visitors were also presented with a series of photographs to measure the acceptability of vegetation loss (Figure 19, Table 9). These photographs simulated increasing levels of recreational use and associated decreases in vegetation. Visitor responses indicated that the majority of people found conditions acceptable in photographs 1-2. There was a wide range of reaction to conditions in photograph 3, but still the majority found it acceptable. The majority of visitors found conditions in photographs 4-6 unacceptable. These results suggest that a low level of vegetation loss is acceptable to most people.

Table 7. Results from surveys asking Coyote Canyon visitors the extent to which they agreed or disagreed with the importance of certain attributes to the overall value of Anza-Borrego Desert State Park®. Answers were on a scale of 1 to 5, with 1 meaning "very unimportant" and 5 meaning "very important". Mn = mean, Md = median, Sd = standard deviation. (From Freimund and Peel 2001).

	Importance ratings		
Park attributes	**Mn**	**Md**	**Sd**
Scenic Beauty	4.62	5.00	0.68
Unique Characteristics	4.59	5.00	0.75
Wildness	4.54	5.00	0.70
Nature Displays	4.49	5.00	0.73
Sanctuary for Wildlife	4.41	5.00	0.82
Preserve for Endangered Species	4.38	5.00	0.97
Essential Wildlife Habitat	4.41	5.00	0.83
Reserve for Natural Resources	4.24	4.00	0.95
Paleontological Resources	4.08	4.00	1.09
Historic Value	4.02	4.00	1.06
A Place Used for Enjoyment	4.33	5.00	0.90
Nature Education	3.97	4.00	1.04
Scientific Research	3.80	4.00	1.31
Recreation Opportunities	4.22	4.00	0.95
As a Tourist Destination	3.40	3.00	1.29
Economic Impact on Community	3.40	3.00	1.48
Family Traditions and Values	3.62	4.00	1.30
A Place Free of Regulations	3.68	4.00	1.29
Social Interactions	3.31	3.00	1.27

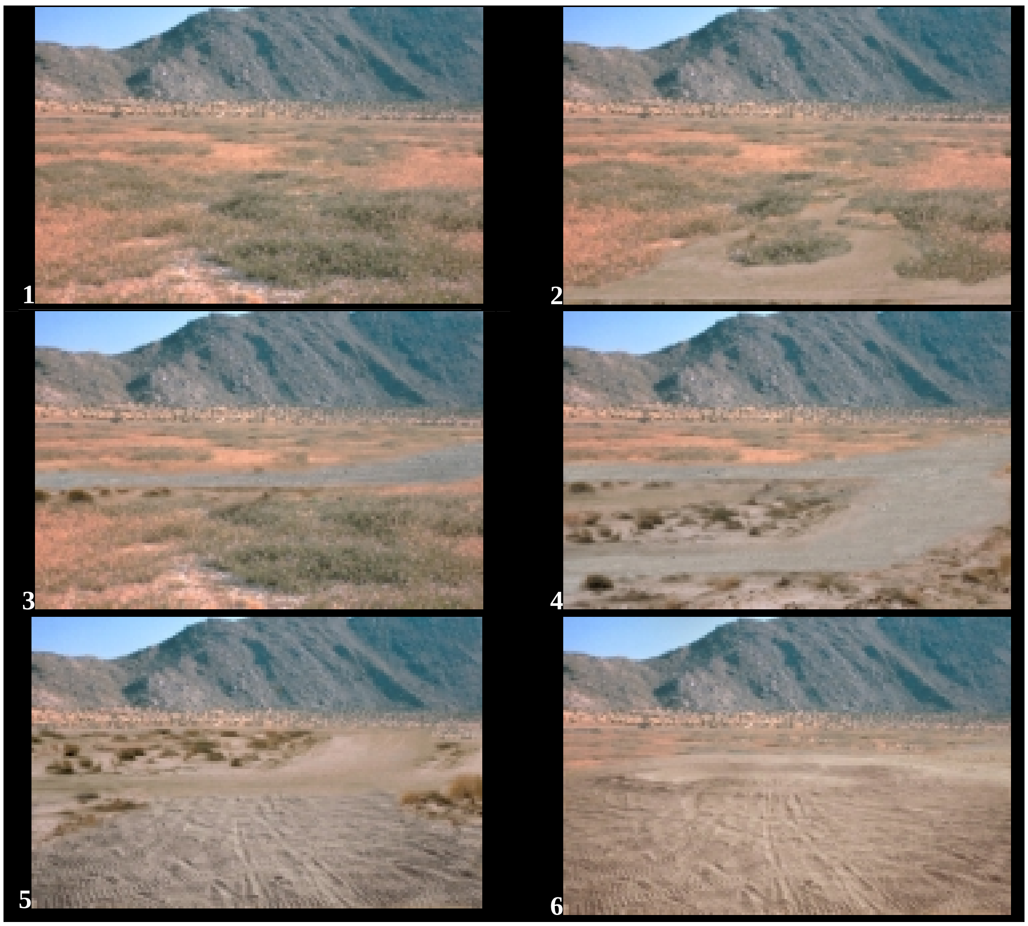
Table 8. Visitor support or agreement with various management actions. Coyote Canyon visitors were asked to rate their support of management actions within the Park. Answers were on a scale of 1 to 5, with 1 meaning strongly oppose and 5 meaning strongly support. Mn = mean, Md = median, Sd = standard deviation. (From Freimund and Peel 2001).

	Support ratings		
Management Actions	**Mn**	**Md**	**Sd**
Resources should be protected	4.60	5.00	0.63
Wildlife populations should be protected	4.58	5.00	0.67
Solitude should be protected	4.55	5.00	0.73
Ecosystem management should be a priority	4.29	5.00	0.91
Wildlife should be a management priority	4.38	5.00	0.82
Historical sites should be protected	4.40	5.00	0.71
History should be a management priority	3.93	4.00	0.85
Camping is managed effectively	4.10	4.00	0.78
Traffic is managed effectively	4.09	4.00	0.79
Park's culture should be a management priority	3.88	4.00	0.87
More info on off-road impacts is needed	3.77	4.00	1.01
Recreation should be protected	4.27	4.00	0.83
Safety should be a management priority	3.71	4.00	1.04
More info on area's ecology	3.78	4.00	0.88
More info on area's history	3.75	4.00	0.89
More info on visitor impacts	3.68	4.00	0.90
Horseback is managed effectively	3.87	4.00	0.97
Off-road is managed effectively	3.94	4.00	1.01
Mountain biking is managed effectively	3.82	4.00	0.97
More info on area's culture	3.68	4.00	0.90
Decisions include community	3.85	4.00	0.92
Recreation should be a management priority	3.83	4.00	0.98
Decisions involve park visitors	3.76	4.00	0.92
Decisions reflect visitor's desires	3.72	4.00	1.03
More hiking trails are needed	3.29	3.00	1.02
More interpretive displays are needed	3.32	3.00	0.92
More signs are needed	3.18	3.00	1.03
More areas for camping are needed	3.08	3.00	1.03
Local residents take priority	3.16	3.00	1.14
More off-road use is needed	2.91	2.00	1.35

Table 9. Range of acceptability of photos showing simulated vegetation loss in Coyote Canyon as shown in Figure 19 (From Freimund and Peel 2001). Photos are in order of increasing vegetation loss.

Simulated Vegetation Loss	Acceptable No.	Acceptable %	Neutral No.	Neutral %	Unacceptable No.	Unacceptable %	Total
Photo 1	251	91.2	14	5.1	10	3.6	275
Photo 2	249	90.5	16	5.8	10	3.6	275
Photo 3	205	75.6	30	11.1	36	13.3	271
Photo 4	102	37.6	34	9.5	137	50.2	273
Photo 5	49	18.0	18	5.0	205	75.4	272
Photo 6	40	14.7	15	4.2	217	79.8	272

Figure 19. Photo series presented to Coyote Canyon visitors by Freimund and Peel (2001). Each photo represents an increasing level of vegetation loss.



Conclusion

Because both visitor use surveys were conducted after the Public Use Plan was implemented, the results do not reflect the full range of past or potential users. However, survey results indicated that the majority of people visiting Coyote Canyon after the Plan was implemented supported the current management actions and had high quality recreational experiences. Although closure of the road between Middle and Upper Willows was a controversial aspect of the Coyote Canyon Public Use Plan, survey results (Freimund and Peel 2001) demonstrated that most visitors to Coyote Canyon (and the park in general) in recent years opposed increasing off-road vehicle access and strongly supported management protecting natural resources. Furthermore, it is important to note that visitors surveyed in other areas of the park gave the same general responses as visitors in Coyote Canyon.

Finding the proper balance between resource protection and recreational opportunity is a challenging task. Visitors come to ABDSP for many reasons and have a wide range of opinions about what role the park should serve (Freimund and Peel 2001). It is not possible to satisfy everyone, but available evidence indicates that most visitors value the quality of recreation currently available in Coyote Canyon, and that they support actions such as the road closure through Middle and Upper Willows to enhance resource protection.

CONCLUSIONS

We examined monitoring data and results from a variety of sources in order to evaluate recreational quality, resource health, and resource protection in Coyote Canyon following implementation of the Coyote Canyon General Use Plan. Overall, we concluded that recreational quality in the canyon was high, that the health or status of natural resources was improving or stable, and that resource protection was improved.

Implementation of the Coyote Canyon Public Use Plan provided a high quality of recreation in the canyon for recent visitors. Because surveys were conducted after the Plan was implemented, the results do not reflect the full range of past or potential users. However, the visitors surveyed valued the canyon's scenic beauty, unique characteristics, wilderness, and nature displays. Ninety-four percent of Coyote Canyon visitors rated their experience as good or excellent. Surveys conducted subsequent to implementation of the Public Use Plan show strong support for the current park management, with visitors ranking protection of natural resources as a top management priority. The least supported management action (according to visitors in Coyote Canyon and park-wide) was to increase off-road vehicle access. The majority of Coyote Canyon users (57%) were positively affected by changes associated with the Public Use Plan. Fewer (13%) Coyote Canyon users were negatively impacted by management changes, while 26% had no comment and 4% had comments unrelated to the Public Use Plan.

The condition or health of natural resources in Coyote Canyon either improved or remained stable subsequent to Public Use Plan implementation. The physical structure of Coyote Creek demonstrated improvement, in that negative impacts from motorized vehicle use (e.g. streambed incision) ceased. This facilitated recovery of an increasingly natural streambed profile. The significant increases in riparian vegetation cover and structure that occurred improved habitat conditions for a variety of species. Furthermore, the overall status or health of two endangered species – bighorn sheep and least Bell's vireo – has improved. Increased survival rates of juvenile and adult bighorn sheep suggest the bighorn sheep population in the canyon is poised to increase if adult survival rates remain high. The number of nesting vireo in the canyon increased and changes in riparian vegetation improved vireo nesting and foraging habitat. Monitoring of amphibians was less informative, but the distribution of amphibian species in Coyote Canyon appeared to remain relatively stable during the monitoring period. Although the health or status of several components of the system improved, desert ecosystems typically take many years to fully recover from negative impacts.

Resource protection in the canyon improved as a result of implementation of the Coyote Canyon Public Use Plan. Negative impacts of motorized vehicle use in desert environments and riparian systems are well documented in the scientific literature. Another important consequence of the Public Use Plan is the increased protection provided to natural processes. Maintaining the integrity of fundamental processes such as vegetation succession and disturbance regimes (floods) is essential to the long-term health of the Coyote Canyon ecosystem. Habitat for a variety of species is created and maintained by flood events. Actions specified in the Public Use Plan directly or indirectly increased the level of protection provided to the processes that shape the canyon and maintain its exceptional biological and aesthetic value.

In conclusion, there was convincing evidence that the Plan provided a high quality of recreation, improved or stablilized natural resource health, and improved resource protection. Scientific literature and monitoring data support the conclusion that management actions specified by the Plan, particularly the road closure and cowbird and tamarisk control, were beneficial.

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APPENDIX A: VISITOR USE SURVEY ADMINISTERED BY ANZA-BORREGO DESERT STATE PARK® PERSONNEL

Coyote Canyon Public Use Questionnaire   Conducted by Anza-Borrego Desert State Park

1. Dates of visit (month, day, year): ______ to ______ If 1 day, how many hours was your visit? ___

2. Number of people in your group? ________   3. Your zip code: _______

4. Type of vecicle(s) used: (circle one or more) 4-wheel drive 2-wheel drive Motorcycle Horse

Bicycle On foot only

5. Your destination(s) in the canyon? Desert Gardens Horse Camp Creek below Lower Willows

Lower Willows Collins Valley Sheep Cyn Cougar Cyn Middle Willows Bailey's cabin Upper Willows

Other ____

6. Types of recreation you or your group took part in? (Circle one or more) Off-highway driving Bicycling

Hiking Horseback riding Camping Nature watching Picnicking Backpacking Photography

7. Have you been to Coyote Canyon before? Yes No

If Yes, do you visit an average of: (circle one) More than once a year Once a year Less than once a year

8. What type of experience were you seeking? Wilderness sightseeing nature viewing

off-highway driving horseback riding mountain biking other ______________________________

9. Did recent changes in Public Use effect your experience? If so, how? (Changes included: routing of horse, hiking, and bike trails off motor vehicle roads in some areas, closure of Middle to Upper Willows to motor vehicles, camping restrictions within the three oases).

____

____

____

10. Overall, how would you rate the quality of your recreational experience in Coyote Canyon? (circle one)

Poor Fair Good Excellent

11. Do you have any suggestions to improve the quality of visitor's experience in Coyote Canyon, while maintaining the protection of natural and recreational resources?

____

____

____

Any comments regarding recreation in Coyote Canyon?

____

____

____

Please return the completed questionnaire – You can hand it to the Park Aid or volunteer on your way out of the canyon or mail to: Anza-Borrego Desert State Park, 200 Palm Canyon Drive, Borrego Springs, CA 92004 Phone (760)767-5311.

APPENDIX B: VISITOR USE SURVEY ADMINISTERED BY FREIDMUND & PEEL (2001)

Anza – Borrego Desert State Park®
Visitor Survey

I. Describe yourself

1. Where do you live?
   Zip code, if US resident ___________
   Country, if International ____________

2. Gender:
   [ ] Male
   [ ] Female

3. In what year were you born? ____________

4. Circle the number of the highest year of formal education you have completed.

   6 7 8 9 10 11 12 13 14 15 16 17+

5. Which of the following best describes the community in which you currently live?

[ ] Farm or ranch	
[ ] Rural or small town	(under 1,000 population)
[ ] Town	(under 10,000 population)
[ ] Small city	(under 75,000 population)
[ ] Medium city	(under 1 million population)
[ ] Large city, metropolitan area	(over 1 million population)

6. What is your approximate total annual household income?

[ ] Less than $ 5,000	[ ] $ 25,000 to $ 34,999
[ ] $ 5,000 to $ 9,999	[ ] $ 35,000 to $ 49,999
[ ] $10,000 to $ 14,999	[ ] $ 50,000 to $ 74,999
[ ] $ 15,000 to $ 19,999	[ ] $ 75,000 to $ 100,000
[ ] $ 20,000 to $ 24,999	[ ] Over $ 100,000

II. Describe your visit

7. How many members of your group are there, including yourself?

[ ] 1	[ ] 5-6
[ ] 2	[ ] 7-10
[ ] 3-4	[ ] More than 10

8. Which of the following best describes the group you are with? (please check all that apply)

[ ] Family	[ ] Commercial tour group
[ ] Friends	[ ] School group
[ ] Family and friends	[ ] Other ____________________
[ ] Organized group	please describe

9. What will be the length of this visit to Anza - Borrego?

[ ] Today only	[ ] 4 – 6 nights
[ ] Overnight	[ ] 7 – 13 nights
[ ] 2 nights	[ ] 14 nights or more
[ ] 3 nights	

10. Approximately how long has it been since your last visit to Anza - Borrego?

[ ] First visit
[ ] 6 months or less
[ ] 7 – 12 months
[ ] More than 12 months, less than 2 years
[ ] More than 2 years, less than 5 years
[ ] More than 5 years, less than 10 years
[ ] 10 years or more

11. Including this visit, how many times have you been to Anza - Borrego?

[ ] 1
[ ] 2
[ ] 3
[ ] 4
[ ] 5 – 7
[ ] 8 – 10
[ ] More than 10 times

12. Which of the following best describes your primary mode of transportation while in the Park?

[ ] Automobile, minivan
[ ] Sport utility, 4wd truck, Jeep
[ ] Passenger van
[ ] Motor home
[ ] Tour bus
[ ] School bus
[ ] Motorcycle
[ ] Bicycle
[ ] Other ______________________

13. How did you first become aware of Anza - Borrego?

[ ] Signs
[ ] Road maps
[ ] Guide books
[ ] The Internet
[ ] Travel agency
[ ] Newspaper feature
[ ] Broadcast media (radio, television)
[ ] Information from California State Parks
[ ] Word of mouth (friends, family, association)
[ ] Information from hotels/motels/campgrounds, etc.
[ ] Other ______________________________

14. Do you plan to visit Anza - Borrego again?

[ ] Yes
[ ] No
[ ] Maybe

15. Did you stay overnight in the Park?

[ ] Yes
[ ] No

16. If "Yes", where did you stay?

[ ] Local hotel/motel
[ ] Developed campsite in Park
[ ] Primitive campsite in Park
[ ] 'Open' camping within Park
[ ] My permanent, local residence
[ ] My seasonal, local residence
[ ] Permanent residence of family/friends
[ ] Seasonal residence of family/friends
[ ] Other ______________________

III. Tell us about your reasons for visiting Anza – Borrego

17. People visit Anza – Borrego Desert State Park for a number of reasons, and many people feel they benefit from their experiences at Anza –Borrego. Listed on the following page are some possible reasons why people might visit and what they might enjoy.

In the table on the following page, rate how **important** each reason is for *you and your visit* to Anza – Borrego. A rating of “1” means the reason was very unimportant and a “5” means the reason was very important to you (circle one number for each item). If you are unsure or don’t know how important the item is to you, mark the “X.”

Reason/Experience	Very unimportant	Unimportant	Neutral	Important	Very important	Don’t know
To have adventure	1	2	3	4	5	X
To develop my own skills & abilities	1	2	3	4	5	X
To do something with my family	1	2	3	4	5	X
To enjoy natural scenery	1	2	3	4	5	X
To be with members of my own group	1	2	3	4	5	X
To be with people who enjoy the same things as I	1	2	3	4	5	X
To have thrills	1	2	3	4	5	X
To have fun	1	2	3	4	5	X
To learn about the area’s natural history	1	2	3	4	5	X
To keep (or get) physically fit	1	2	3	4	5	X
To meet and talk to new people	1	2	3	4	5	X
To experience new and different things	1	2	3	4	5	X
To learn more about nature	1	2	3	4	5	X
To rest physically	1	2	3	4	5	X
To be challenged	1	2	3	4	5	X
To experience excitement	1	2	3	4	5	X
To learn more about the area’s cultural history	1	2	3	4	5	X
To reflect on and clarify personal values	1	2	3	4	5	X
To do something creative, such as photography	1	2	3	4	5	X
To get away from the usual demands of life	1	2	3	4	5	X
To get away from crowds	1	2	3	4	5	X
To escape the family temporarily	1	2	3	4	5	X
To share what I know with others	1	2	3	4	5	X
To bring my family/group closer together	1	2	3	4	5	X
To feel more self-confident	1	2	3	4	5	X
To view wildlife	1	2	3	4	5	X
To help others develop their skills	1	2	3	4	5	X
To view desert bighorn sheep in a natural setting	1	2	3	4	5	X
To experience the tranquility in the park	1	2	3	4	5	X
To be more productive at work/school/home	1	2	3	4	5	X
To be at a place where I can make my own decisions	1	2	3	4	5	X
To reduce built-up tension	1	2	3	4	5	X
To allow my mind to move at a slower pace	1	2	3	4	5	X
To experience peace and quiet	1	2	3	4	5	X
To experience the wildflower display	1	2	3	4	5	X
To see the desert	1	2	3	4	5	X
To camp or hike in a wild, natural setting	1	2	3	4	5	X
To teach environmental awareness to members of my group	1	2	3	4	5	X

IV. Describe why Anza – Borrego is important to you

Anza-Borrego Desert State Park is particularly important:

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Don't know
Because of its wildness	1	2	3	4	5	X
Because of its scenic beauty	1	2	3	4	5	X
Because of its unique characteristics	1	2	3	4	5	X
As essential habitat for animals	1	2	3	4	5	X
Because of its outstanding displays of nature	1	2	3	4	5	X
As a sanctuary for wildlife	1	2	3	4	5	X
Because of its historical value	1	2	3	4	5	X
Because of its paleontological resources	1	2	3	4	5	X
For scientific research	1	2	3	4	5	X
For social interaction	1	2	3	4	5	X
For education about nature	1	2	3	4	5	X
Because of its recreational opportunities	1	2	3	4	5	X
For carrying on family traditions and values	1	2	3	4	5	X
As a tourist destination	1	2	3	4	5	X
As a reserve of natural resources	1	2	3	4	5	X
Because of its economic impact on the community	1	2	3	4	5	X
As a place to be free of society and regulations	1	2	3	4	5	X
As a place for the use and enjoyment of everyone	1	2	3	4	5	X
As a preserve for threatened and endangered species	1	2	3	4	5	X

V. Tell us what you think of the quality of Park management in Anza – Borrego.

In the following table are a number of statements regarding how you think Anza Borrego is being managed, or how it should be managed. Please mark your level of agreement or disagreement with each statement.

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Don't know
A functioning natural ecosystem should be a management priority	1	2	3	4	5	X
Recreation opportunities for visitors should be a management priority	1	2	3	4	5	X
Healthy wildlife populations should be a management priority	1	2	3	4	5	X
Interpreting the Park's cultural history should be a management priority	1	2	3	4	5	X
Ensuring the safety and security of visitors should be a management priority	1	2	3	4	5	X
Interpreting the Park's natural history should be a management priority	1	2	3	4	5	X
Off-road vehicle use within the Park is being managed effectively	1	2	3	4	5	X
Mountain bike use within the Park is being managed effectively	1	2	3	4	5	X
Horseback use within the Park is being managed effectively	1	2	3	4	5	X
Camping within the Park is being managed effectively	1	2	3	4	5	X
Traffic within the Park is being managed effectively	1	2	3	4	5	X
Peace and solitude should be protected within the Park	1	2	3	4	5	X
Natural features and resources should be protected within the Park	1	2	3	4	5	X
Wildlife populations should be protected within the Park	1	2	3	4	5	X
Recreational opportunities should be protected within the Park	1	2	3	4	5	X
Important cultural/historical sites should be protected within the Park	1	2	3	4	5	X
The Park should provide more information on visitor impacts	1	2	3	4	5	X
The Park should provide more information about off-road impacts	1	2	3	4	5	X
The Park should provide more information on the area's culture & history	1	2	3	4	5	X
The Park should provide more information on the area's natural history	1	2	3	4	5	X
The Park should provide more information on the area's ecology	1	2	3	4	5	X
The Park should provide more areas for camping	1	2	3	4	5	X
The Park should provide more hiking trails	1	2	3	4	5	X
The Park should provide more opportunities for off-road recreation	1	2	3	4	5	X
The Park should provide more interpretive displays	1	2	3	4	5	X
The Park should provide more signs	1	2	3	4	5	X
Park planning decisions should include input from the local community	1	2	3	4	5	X
Input from local residents should take priority in Park planning decisions	1	2	3	4	5	X
Park planning decisions should involve Park visitors	1	2	3	4	5	X
Park planning decisions should reflect the public's desires	1	2	3	4	5	X

One of the issues in managing Anza-Borrego Desert State Park is to balance recreational use with the loss of vegetation. The computer-generated photographs simulate a range of vegetation loss that can result from recreational use. The managers are interested in your opinion on **how vegetation loss affects your experience**. To help us assess this, please indicate the **acceptability of the conditions** represented by each photo. A rating of -4 signifies conditions are very unacceptable; a rating of +4 is very acceptable

Photo	Very Unacceptable						Very Acceptable		
1	-4	-3	-2	-1	0	+1	+2	+3	+4
2	-4	-3	-2	-1	0	+1	+2	+3	+4
3	-4	-3	-2	-1	0	+1	+2	+3	+4
4	-4	-3	-2	-1	0	+1	+2	+3	+4
5	-4	-3	-2	-1	0	+1	+2	+3	+4
6	-4	-3	-2	-1	0	+1	+2	+3	+4

Of the six photos, which one represents the conditions you would **prefer**?

Photo: 1 2 3 4 5 6

Which photo represents the **highest level of vegetation loss** the Park should allow, to maintain the quality you prefer?

Photo: 1 2 3 4 5 6

In order to maintain that quality, what management actions should the Park undertake? Please mark your level of agreement or disagreement with the following:

	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Don't know
Increase ranger patrols and law enforcement to keep people on roads	**1**	**2**	**3**	**4**	**5**	**X**
Provide information about less-used sites in the Park	**1**	**2**	**3**	**4**	**5**	**X**
Institute a permit system for off-road backcountry visitors	**1**	**2**	**3**	**4**	**5**	**X**
Designate certain areas (zones) for specific recreation purposes	**1**	**2**	**3**	**4**	**5**	**X**
Provide an edge (curb, fence, rocks) to roads to contain motorized travel	**1**	**2**	**3**	**4**	**5**	**X**
Close some roads and trails to motorized vehicles	**1**	**2**	**3**	**4**	**5**	**X**
Prohibit roadside camping in certain areas	**1**	**2**	**3**	**4**	**5**	**X**

VI. Additional comments about issues related to the Park

If you have other comments or suggestions about Anza–Borrego Desert State Park, please tell us in the space below.